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96
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Agricultural Potential

of selected areas

within the

LOWER MISSISSIPPI ALLUVIAL VALLEY

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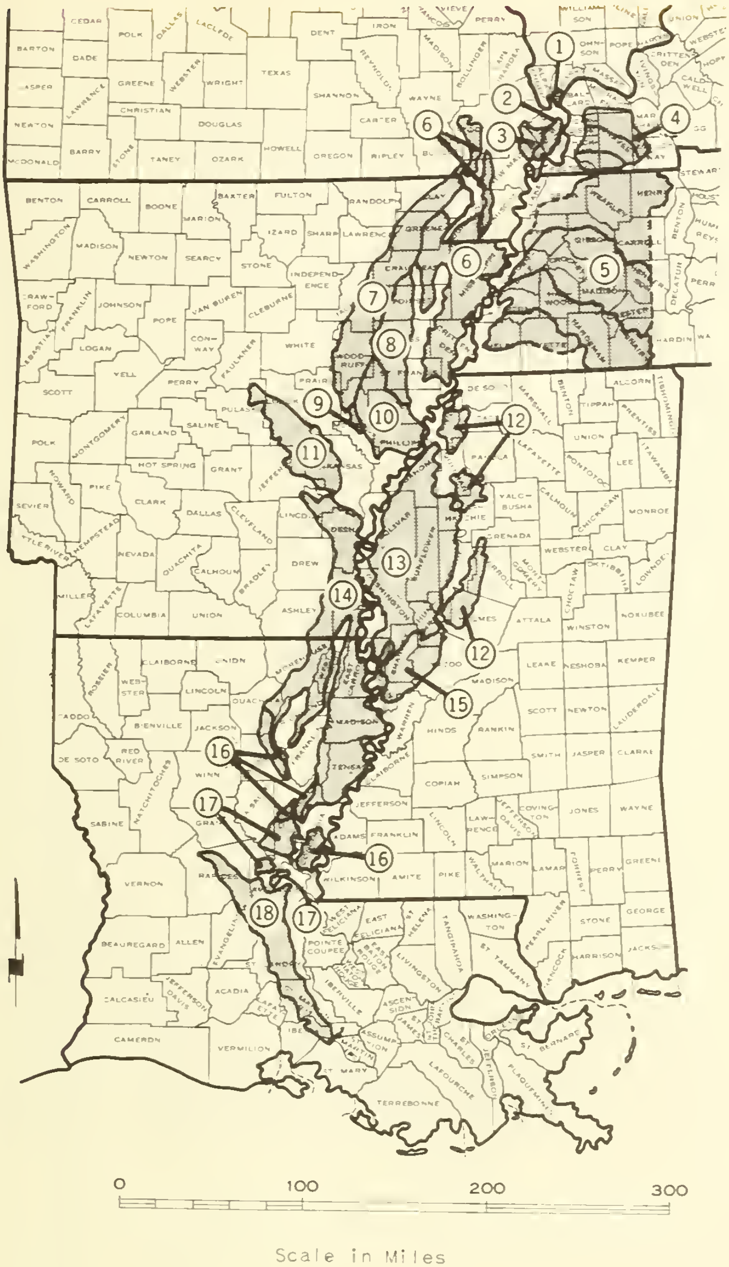

KEY TO M.R.&T. PROJECTS

1. Cario-D.D. Mounds-Mound City
2. New Madrid Levee
3. St. John Bayou
4. West Kentucky Tributaries (Comprised of Mayfield Creek, Obion Creek, and Bayou Du Chien)
5. West Tennessee Tributaries (Comprised of Obion River, Forked Deer River, Hatchie-Tuscumbia River, and Loosahatchie River)
6. St. Francis River and Tributaries
7. Cache River Basin
8. L'Anguille River Basin
9. Dials Creek Basin
10. Big Creek Basin
11. Bayou Meto Basin
12. Yazoo Headwater (Comprised of McKinney Bayou, Whiteoak Bayou, Potacocowa Creek, Big Sand Creek, Pelucia Creek, and Hillside Floodway)
13. Big Sunflower
14. Boeuf-Tensas-Macon Basin (Comprised of Boeuf River, Tensas River, Big and Colewa Creek, and Bayou Macon)
15. Yazoo Backwater
16. Red River Backwater (Vicksburg District)
17. Red River Backwater (New Orleans District)
18. Intercepted Drainage West of West Achafalaya

Vicinity map, Mississippi River and Tributaries Project, Illinois, Kentucky, Missouri, Arkonsas, Mississippi, and Louisiona.

FOREWORD

Although certain parts of the Mississippi River Delta have been under cultivation for more than 200 years, the Delta, as a whole, has great potential for future agricultural development in the Nation. As the need for agricultural products increases over the years, this potential can be developed at a comparatively reasonable cost.

Past agricultural development in the Delta has taken place only after a certain measure of flood protection has been provided. The comprehensive flood-protection system on the lower Mississippi River provides a high degree of protection. However, certain development awaits further protection. The Delta is characterized by a preponderance of heavy clay, silty clay, and silt loam soils. The optimum agricultural potential of these soils cannot be realized without the removal of excess surface water. The degree of drainage in the Delta lags behind that of flood protection; thus the key to unlocking the great agricultural potential lies partly in further flood control but to a greater extent in more complete and adequate drainage.

Three types of drainage are recognized as essential. First, there must be major drainage canals or outlets. Then there must be intermediate or group-type drainage to connect the individual farms to those major outlets. As a final step there must be drainage systems on individual farms to convey excess water from the fields to the intermediate collection systems and thence into the major outlets. Even though cultivated land may have flood protection it is not unusual to double or triple production by supplementing this protection with adequate drainage.

Along with the agricultural potential of the Delta are other equally important potentials that will contribute to our Nation's economy. For instance, it is the best bottom land hardwood-timber-producing area in the country. Under proper management, fast-growth high-quality timber can be produced with a high per-acre yield. Even though we have no present demand for an increase in crop production, this is not true of timber such as is grown in that area. Our ever-growing timber requirements make the timber-producing potential of the Delta increasingly valuable. Although timber production in the area at the present time is high, it is only a fraction of what can be achieved under proper management.

Another important resource of the Delta and one susceptible to extensive future development is wildlife. Both the monetary and nonmonetary values connected with wildlife are important at the present time. However, here again, under proper management, the potentialities are almost beyond imagination.

Industrial development based on the natural resources of the area is a natural culmination of a properly balanced economy. Everything favors a tremendous future expansion in this direction. In addition to a wealth of raw materials, the Delta has labor, markets, transportation, water, favorable climate, and other elements conducive to industrial development not excelled elsewhere in the Nation.

It is apparent that through a concept of multiple-resource use and a harmonizing of certain conflicts of interest the economic future of the Delta is promising. The area reported here is only a part of the entire Delta area. Yet it provides the most complete insight into the agricultural potential of the Delta available. The data should be extremely useful to those interested in, and charged with the responsibility in, having a part in the future economic expansion of the Delta, both from a public and private standpoint.

John A. Short, Chairman
U. S. Dept. of Agriculture Field
Advisory Committee, Mississippi
River and Tributaries Study

AGRICULTURAL POTENTIAL OF SELECTED AREAS WITHIN THE LOWER MISSISSIPPI VALLEY

2

Report by W. G. Eichberger, formerly agricultural economist, Farm Economics Research Division, Agricultural Research Service[1]

CONTENTS

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[1] This report is a summary of separate project reports. John O. Roy, Engineering and Watershed and Planning Unit, Soil Conservation Service, Fort Worth, Tex., furnished the material on water and irrigation; Max J. Edwards, Soil Survey, SCS, Knoxville, Tenn., the material on soils; Phillip R. Wheeler, Chief, Division of Forest Economics Research, and Sam Guttenberg, In Charge of Economics of Management and Utilization, Southern Forest and Range Experiment Station, Forest Service, New Orleans, La., the material on the forest resource and the forest industry.

THE USDA EVALUATION OF POTENTIAL DRAINAGE BENEFITS IN THE LOWER MISSISSIPPI ALLUVIAL VALLEY

This report presents a description of the subproject areas covered in the survey of the Mississippi River and Tributaries Project (MR&T), together with a description of the proposed project works, and finally, the effects of the proposed project on the agricultural economy of each subproject area. It should be borne in mind that in making the analysis, the Department of Agriculture (USDA) assumed adequate flood protection and adequate farm and group drainage systems. It also assumed no production controls or acreage controls for the longrun future situation. Therefore, the data presented do not reflect the shortrun changes in the agricultural economy that might be expected to result from proposed land and water developments in the portions of the alluvial valley covered in the survey.

The changes in major land use and in cropping distributions as presented could be expected to occur only if the Corps of Engineers could provide the degree of flood protection assumed by USDA. Net production returns and installation and maintenance costs of farm and group drainage were properly discounted to account for a lag in accrual of maximum benefits and in incurring costs associated with such benefits. Because of the uncertainty as to the degree of flood protection that might be provided by the proposed project, the yield estimates made by USDA for use in the evaluation are not the full potential yields that most agricultural scientists familiar with the area feel could be economically attained. Therefore, even though it is unlikely that full flood protection could feasibly be provided in all subproject areas, and as flood-damage-reduction benefits are not included, production benefits may be greater than indicated by the data presented.

Physical Characteristics and Extent

USDA covered about 9,828,000 acres in the review study of the Mississippi River and Tributaries Project. Of this total, about 4,410,000 acres, or about 45 percent of the land area included in the survey, lie above the contour of the flood of record. This area, designated as the A zone, is flood-free. About 76 percent, or about 3,343,000 acres of land in the A zone, is open land, of which 667,000 acres, or 20 percent, do not need drainage because of its physical and topographic characteristics; 347,000 acres, about 10 percent, are already drained; and 2,329,000 acres, about 70 percent, are wetland that needs drainage. The latter acreage would benefit from the proposed project drainage. A total of 1,067,000 acres, or about 24 percent of all land in the A zone is woodland.

Within the Mississippi River and Tributaries Project area in the Delta 4,014,000 acres lie within the B zone. Lands in this zone, which lies between the contour of the flood of record and the 3-year flood frequency contour, would benefit from both drainage and flood protection. About 1,713,000 acres, or about 43 percent, are open land. The survey made by USDA revealed that 67,000 acres, about 4 percent, of the open land in the B zone do not need drainage because of physical and topographic characteristics. A total of 360,000 acres, about 21 percent, of the open land is already drained; and 1,286,000 acres are wetland needing drainage. At present, in the B zone, are 2,301,000 acres of woodland, or about 57 percent of the total area.

Lands lying below the 3-year flood frequency contours were considered to be permanently wet. This area, designated as the C zone, contains 1,404,000 acres, of which 224,500 acres or about 16 percent, are open land, and 1,180,000 acres are in woodland. None of the open land in the C zone was considered to have adequate drainage.

Estimated Changes With No Project

USDA estimated that in future with no proposed project development in the land areas studied in the Delta, 165,000 acres of woodland would be converted to open land in the A zone. Of this converted woodland, 27,000 acres were estimated not to need drainage. The total amount of open land without project development was estimated to be 3,508,000 acres, of which 694,000 acres would not need drainage, 347,000 acres are already drained, and 728,000 acres would be drained in the future, making 1,769,000 acres, or about 50 percent of the total estimated open land, drained. About 50 percent of the open land in the A zone, some 1,739,000 acres, was estimated to remain as wet land. About 902,000 acres were estimated to remain in woodland in the A zone if no project were developed in the area.

USDA estimated that in the B zone 266,000 acres of woodland would be converted to open land in the absence of any project development, making 1,979,000 acres of open land. About 3,000 acres of the converted woodland were considered to have such characteristics that they would not require drainage. A total of 69,000 acres of the open land would not require drainage, 360,000 acres are already drained, and 324,000 acres were estimated to be drained in future without any project development. This would mean that 753,000 acres, or 38 percent of all open land in the B zone, would be drained; and 1,226,000 acres, or 62 percent of the open land, would be undrained, wet land. USDA estimated that with no project development 2,035,000 acres would remain in woodland.

The C zone has 1,180,000 acres of woodland, of which USDA estimated that 62,000 acres would be converted to open land without any project development. None of the open land in the C zone, however, is expected to be drained. A total of 1,118,000 acres would remain as woodland without a project.

Estimated Changes With Project

In the event water-control projects were developed that would afford adequate flood protection and adequate farm and group drainage systems, USDA estimated that 642,000 acres of woodland in the A zone, 467,000 acres of which would be attributable to the project, would be converted. This would make 3,985,000 acres of open land, of which 694,000 acres would not require drainage; 1,075,000 acres are either already drained or would be drained in the future even with no project development; and 1,428,000 acres would be drained with the project. In the A zone, 3,492,000 acres were estimated to be drained with the project. This would include land not needing drainage, land already drained, and land to be drained. A total of 88 percent of the open land in the A zone would be drained, and 493,000 acres, or 12 percent would be undrained, wet land. USDA estimated that 425,000 acres in the A zone would remain in woods.

USDA estimated that in the B zone 1,222,000 acres of woodland, of which 956,000 acres would be attributable to the project, would be converted to open land with project development, making 2,935,000 acres of open land in the B zone. Of this acreage, 292,000 acres would not require drainage, 684,000 acres are either already drained or would be drained without project development, and 1,506,000 acres were expected to be drained with the project. About 85 percent of all open land in the B zone was expected to be drained, and 453,000 acres, or about 15 percent of the open land, were expected to remain as wet, undrained land. USDA estimated that 1,079,000 acres in the B zone would remain as woodland.

TABLE A.--Summary of Lower Mississippi River and Tributaries Project: Major land use and drainage, present and estimated future without and with project, soil units and zones

Item	All land in zone			Percentage of zone in-- Open land			Percentage of zone in-- Woodland			Percentage of open land drained[1]		
	A	B	C	A	B	C	A	B	C	A	B	C
	100 acres	*100 acres*	*100 acres*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Soil unit 1:												
Present..............	5,410	23,004	7,637	61	29	5	39	71	95	17	19	0
Without project.......	5,410	23,004	7,637	68	37	9	32	63	91	49	32	0
With project..........	5,410	23,004	7,637	83	63	9	17	37	91	88	83	0
Soil unit 2:												
Present..............	3,216	1,955	697	92	78	38	8	22	62	16	30	0
Without project.......	3,216	1,955	697	96	82	48	4	18	52	63	50	0
With project..........	3,216	1,955	697	99	94	48	1	6	52	94	93	0
Soil unit 3:												
Present..............	1,090	339	--	99	92	--	1	8	--	1	4	--
Without project.......	1,090	339	--	99	95	--	1	5	--	54	16	--
With project..........	1,090	339	--	100	99	--	0	1	--	94	94	--
Soil unit 4:												
Present..............	4,517	2,560	83	88	78	33	12	22	67	15	24	0
Without project.......	4,517	2,560	83	90	81	43	10	19	57	40	43	0
With project..........	4,517	2,560	83	97	95	43	3	5	57	87	86	0
Soil unit 5:												
Present..............	1,355	1,275	208	96	84	45	4	16	55	38	27	0
Without project.......	1,355	1,275	208	99	88	52	1	12	48	95	55	0
With project..........	1,355	1,275	208	99	96	52	1	4	48	97	96	0
Soil unit 6:												
Present..............	2,197	4,011	401	59	48	14	41	52	86	28	40	0
Without project.......	2,197	4,011	401	64	52	27	36	48	73	41	48	0
With project..........	2,197	4,011	401	90	85	27	10	15	73	83	86	0
Soil unit 7:												
Present..............	940	481	265	85	77	71	15	23	29	13	33	0
Without project.......	940	481	265	88	79	77	12	21	23	29	42	0
With project..........	940	481	265	96	91	77	4	9	23	77	87	0
Soil unit 8:												
Present..............	1,253	2,352	4,260	59	48	24	41	52	76	5	11	0
Without project.......	1,253	2,352	4,260	62	53	27	38	47	73	10	17	0
With project..........	1,253	2,352	4,260	83	80	27	17	20	73	80	79	0
Soil unit 9:												
Present..............	6,364	691	40	81	65	75	19	35	25	44	56	0
Without project.......	6,364	691	40	85	69	75	15	31	25	52	67	0
With project..........	6,364	691	40	92	88	75	8	12	25	87	92	0
Soil unit 10:												
Present..............	10,673	2,794	240	66	48	68	34	52	32	10	11	0
Without project.......	10,673	2,794	240	71	55	71	29	45	29	23	21	0
With project..........	10,673	2,794	240	91	83	71	9	17	29	81	78	0
Soil unit 11:												
Present..............	2,286	356	64	93	90	33	7	10	67	100	100	0
Without project.......	2,286	356	64	96	93	70	4	7	30	100	100	0
With project..........	2,286	356	64	96	97	70	4	3	30	100	100	0
Soil unit 12:												
Present..............	1,297	60	6	99	98	40	1	2	60	75	100	0
Without project.......	1,297	60	6	99	100	40	1	0	60	75	98	0
With project..........	1,297	60	6	99	100	40	1	0	60	93	100	0
Soil unit 13:												
Present..............	4	40	1	75	57	0	25	43	100	100	100	0
Without project.......	4	40	1	75	60	0	25	40	100	100	100	0
With project..........	4	40	1	75	60	0	25	40	100	100	100	0
Soil unit 14:												
Present..............	17	200	142	0	0	0	100	100	100	0	0	0
Without project.......	17	200	142	0	0	0	100	100	100	0	0	0
With project..........	17	200	142	0	0	0	100	100	100	0	0	0
Soil unit 15:												
Present..............	2,749	--	--	58	--	--	42	--	--	100	--	--
Without project.......	2,749	--	--	60	--	--	40	--	--	100	--	--
With project..........	2,749	--	--	60	--	--	40	--	--	100	--	--
Soil unit 16:												
Present..............	731	25	--	98	96	--	2	4	--	1	0	--
Without project.......	731	25	--	99	96	--	1	4	--	27	21	--
With project..........	731	25	--	100	96	--	0	4	--	84	83	--
All:												
Present..............	44,099	40,143	14,044	76	43	16	24	57	84	30	25	0
Without project.......	44,099	40,143	14,044	80	49	20	20	51	80	50	38	0
With project..........	44,099	40,143	14,044	90	73	20	10	27	80	88	85	0

[1] Includes naturally and artifically drained land.

TABLE B.--Lower Mississippi River and Tributaries Project--Delta: Estimated effects on cropping systems due to project development

Crop	Percentage change in acreage			Percentage change in production		
	A zone	B zone	All land[1]	A zone	B zone	All land[1]
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Cotton....................	14	45	23	32	74	48
Corn......................	10	61	27	33	115	58
Vegetables................	--	67	42	--	106	84
Rice......................	23	72	34	40	72	57
Soybeans..................	12	51	25	22	86	45
Sugarcane.................	--	-23	-23	--	-13	-13
Small grain...............	17	42	26	32	75	50
All hay...................	32	-8	0	45	19	74
Supplemental pasture......	34	167	63	58	272	103
Melons....................	0	0	0	10	20	15
Grain sorghum.............	14	31	17	49	33	43
Permanent pasture.........	13	60	34	37	113	95
Idle......................	4	-14	-2	--	--	--
Other.....................	14	49	25	--	--	--
Woodland..................	-53	-47	-35	-55	-47	-36
All land...............	0	0	0	34	71	45

[1] No change in acreage, production, or net return in C zone. All land includes C zone.

TABLE C.--Lower Mississippi River and Tributaries Project: Estimated future crop acreages, crop production, and net return without and with project development

Crop	Without project			With project			Difference in net return	Percentage increase in net return
	Acres	Production[1]	Net return	Acres	Production[1]	Net return		
	100 acres	*1,000 units*	*1,000 dollars*	*100 acres*	*1,000 units*	*1,000 dollars*	*1,000 dollars*	*Percent*
Cotton...............	16,369	1,387	29,099	20,090	2,056	45,015	15,916	55
Corn.................	5,391	18,623	10,539	6,832	29,430	18,024	7,485	71
Green vegetables......	12	5.7	43	17	10.5	96	53	123
Rice.................	3,192	9,281	3,695	4,288	14,530	7,442	3,747	101
Lima beans...........	(10)	0.3	6	(16)	0.5	15	9	150
Soybeans.............	11,262	25,270	26,193	14,132	36,695	40,864	14,671	56
Sugarcane............	30	52	16	23	45	17	1	6
Small grain..........	5,259	16,550	4,462	6,647	24,730	7,395	2,933	66
All hay..............	123	30	178	123	52	249	71	40
Oats pasture.........	(1,774)	22,025	2,201	(2,845)	44,752	4,189	1,988	90
Melons...............	12	359	11	12	412	16	5	45
Grain sorghum........	630	1,349	812	735	1,933	950	138	17
Permanent pasture.....	6,963	158,752	11,101	9,312	310,142	18,484	7,383	67
Idle.................	2,767	--	--	2,703	--	--	--	--
Other................	5,722	--	--	7,152	--	--	--	--
Woodland.............	40,554	--	13,245	26,220	--	8,808	-4,437	-34
Total............	98,286	--	101,601	98,286	--	151,564	49,963	49

[1] Cotton--500-pound bales; corn, soybeans, oats, and grain sorghum--bushels; rice--hundredweights; beef--pounds.

No additional woodland conversions and no drainage was anticipated to occur in the C zone with project development. With project development, it was estimated that 286,000 acres would be open, undrained land, and 1,118,000 acres would be in woods.

The estimated changes in major land use and drainage by soil units and zones are shown in table A.

Anticipated Effects

Assuming project development of the type that would afford adequate flood protection and drainage in the area studied in the lower Mississippi alluvial valley, USDA estimated that total agricultural production could be increased 45 percent and annual net agricultural income 49 percent. These increases in production and annual net agricultural income are expected to result from changes in major land use and changes in cropping systems, as indicated in tables B and C. The estimated changes expected to occur under varying conditions of land development are shown in table D.

The estimated crop yields used by USDA are shown in table E. These yields are averages for all soils included in the project areas within each State. The increases in crop yields without a project are expected to result from technology. The increases in yields with a project over the without-project condition are expected to result from the project.

As indicated in table D, 2,984,000 acres were expected by USDA to be drained with project development. The total associated cost of land development in the entire project area was estimated at $172,491,000, with the annual equivalent including annual cost of farm drainage maintenance estimated at $18,340,000. The total value of the increase in annual net agricultural income in the project area was estimated at $49,507,000. The discounted values of annual net agricultural income and of annual equivalent associated costs were estimated at $26,108,000 and $11,530,000, respectively.

The Importance of Delta Agriculture

Principal crops grown in the Delta include cotton, soybeans, corn, rice, and oats. Of the total acreage harvested of these major crops in Arkansas, Louisiana, Mississippi, and Missouri, which contain about 96 percent of all Delta land, 54 percent of all soybeans, 72 percent of all cotton, 19 percent of all corn, 29 percent of all oats, and 88 percent of all rice are produced in the Delta. These percentages indicate the importance of the Delta to the agricultural economy of the region.

TABLE D.--Mississippi River and Tributaries Project Area in the lower Mississippi alluvial valley: Project summary

Item	Amount
Drainage operations:	*Acres*
Woodland converted to open cropland.....	1,423,000
Farmland drained.......................	2,984,000
Associated costs:	
Initial:	*Dollars*
Woodland conversion..................	103,310,000
Farm drainage installations..........	40,978,000
Group drainage installations..........	28,203,000
Total associated costs.............	172,491,000
Annual equivalent:	
Conversion...........................	5,760,000
Farm drainage........................	4,966,000
Group drainage.......................	3,261,000
Annual farm drainage maintenance........	4,353,000
Total annual costs..................	18,340,000
Annual increase in net farm income........	49,963,000
Discounted value of:	
Annual increase in net farm income......	26,108,000
Annual associated costs................	11,530,000
Unadjusted benefits..................	14,578,000

Of all cotton produced in the United States in 1954, 21 percent was produced in the Mississippi Delta on 17 percent of the total cotton acreage harvested in the United States. Of all rice harvested in the United States in 1954, 49 percent was produced in this region on 44 percent of the total rice acreage harvested in the United States. The region also accounted for 7 percent of all soybeans in the United States on 12 percent of the total soybean acreage harvested. Thus, it can be seen that the Mississippi Delta is an important contributor to the national production of cotton, soybeans, and rice.

In the future with project development, the Delta can be expected to furnish a fair share of the Nation's requirements of specified products. Table F shows the increase in production of specified agricultural products required in 1975, the increase in production which it is estimated could come from the Delta, and the percentage of the total requirements of the Nation that could be met by the increased production in the Delta. It may be noted that the estimated increase in cotton production could make up a significant portion of the estimated national need, while any increase in production of rice would add to a surplus.

TABLE E.--Estimated average[1] crop yields used by the Department of Agriculture in the evaluation of drainage benefits in the Lower Mississippi River and Tributaries Project

State	Cotton--pounds lint					Corn--bushels				
	Present yield	Yield without project	Percent increase	Yield with project	Percent increase	Present yield	Yield without project	Percent increase	Yield with project	Percent increase
Arkansas........................	347	408	18	488	20	28	37	32	42	14
Illinois........................	300	350	17	450	29	30	33	10	54	64
Kentucky........................	--	--	--	--	--	34	43	26	52	21
Louisiana.......................	286	375	31	490	31	33	38	15	47	24
Mississippi.....................	431	534	24	582	9	31	37	19	42	14
Missouri........................	285	322	13	403	25	25	28	12	44	57
Tennessee.......................	241	289	20	366	27	23	28	22	34	21
Delta.......................	347	424	22	492	16	29	35	21	43	23

[1] The average yields shown are a composite of all soils and all degrees of wetness. Actually there was a wide spread between yields among soils and soil conditions. The averages shown in the table were not used to obtain the results but rather each soil association and soil condition was analyzed individually.

TABLE E.--Estimated average[1] crop yields used by the Department of Agriculture in the evaluation of drainage benefits in the Lower Mississippi River and Tributaries Project--Continued

State	Rice--hundredweight					Soybeans--bushels				
	Present yield	Yield without project	Percent increase	Yield with project	Percent increase	Present yield	Yield without project	Percent increase	Yield with project	Percent increase
Arkansas	26.5	28.8	9	33.1	15	17	21	24	22	5
Illinois	--	--	--	--	--	20	23	15	29	26
Kentucky	--	--	--	--	--	19	25	32	26	4
Louisiana	--	--	--	--	--	21	25	19	32	28
Mississippi	25.7	26.3	2	28.7	9	19	27	42	32	19
Missouri	--	--	--	--	--	17	19	12	25	32
Tennessee	--	--	--	--	--	17	20	18	23	15
Delta	26.4	28.8	9	33.1	15	18	22	22	26	18
	Small grain--bushels					Permanent pasture--pounds beef				
Arkansas	24	31	29	37	19	177	243	37	305	26
Illinois	16	19	19	28	47	100	110	10	124	13
Kentucky	--	--	--	--	--	160	193	21	219	13
Louisiana	35	38	9	45	18	204	219	7	307	40
Mississippi	32	34	6	39	15	200	243	21	283	16
Missouri	16	20	25	22	10	119	145	22	178	23
Tennessee	--	--	--	--	--	142	192	35	242	26
Delta	27	33	22	39	18	186	228	23	289	27

[1] The average yields shown are a composite of all soils and all degrees of wetness. Actually there was a wide spread between yields among soils and soil conditions. The averages shown in the table were not used to obtain the results but rather each soil association and soil condition was analyzed individually.

TABLE F.--Estimated effects of Lower Mississippi River and Tributaries Project on projected national requirements for selected crops and livestock[1]

Commodity	United States			Increased production from Delta	Percentage of United States requirement, 1975
	1955 production	1975 requirement (percentage of 1955)	Increase over 1955		
Corn	3,185 mil. bu.	+34	1,083 mil. bu.	10.8 mil. bu.	1
Soybeans	371 mil. bu.	+26	96 mil. bu.	11.4 mil. bu.	12
Rice	53.4 mil. cwt.	-16	-8.5 mil. cwt.	5.2 mil. cwt.	
Cotton	14.7 mil. bales	+20	2.9 mil. bales	0.67 mil. bales	23
Beef[2]	26,156 mil. lbs.	+36	9,416 mil. lbs.	174 mil. lbs.	2
Grain sorghum	233 mil. bu.	+4	9.3 mil. bu.	0.58 mil. bu.	6

[1] Projected needs data from U.S. Dept. Agr., Agr. Inform. Bul. 162, pp. 17 and 23.
[2] 1954 production.

INTRODUCTION

In May 1955, the Corps of Engineers, U.S. Army, conferred with the U.S. Department of Agriculture (USDA) concerning cooperative studies in the lower Mississippi River Basin relative to plans for land and water-resource development. The Corps was starting a review study of the Mississippi River and Tributaries Project (MR&T), authorized in the 1928 Flood Control Act as modified by subsequent acts, to examine the adequacy of the proposed project together with modifications or additions that might be necessary. At the request of the Corps, USDA agreed to supply certain basic agricultural data and information for use in the economic analysis. The MR&T project consisted of the alignment, clearing, and snagging of channels and the construction of other water-control works to alleviate flooding and drainage problems in the lower Mississippi alluvial valley.

Authority for USDA participation was provided by section 6 of the Watershed Protection and Flood Prevention Act (Public Law 566, 83d Cong., as amended). It authorizes USDA to cooperate with other Federal, State, and local groups or agencies in surveys and investigations of river basins as a basis for the development of coordinated programs.

The USDA study was directed by a field advisory committee composed of one member each from the Soil Conservation Service, Forest Service, and Agricultural Research Service, with the Soil Conservation Service member serving as chairman. Surveys were made in each State by teams composed of engineers, soil scientists, foresters, and agricultural economists. Soil Conservation Service was responsible for engineering and soils data and completion and submission of the USDA reports to the Corps, the Forest Service for forestry data, and the Agricultural Research Service for economic aspects of the survey. The three agencies worked cooperatively in developing yields, land use, irrigation, drainage, and economic data and in writing the reports.

The study covered 19 project areas within the lower Mississippi River Basin that would be affected by the proposed project. Several hillside tributary areas were also studied to determine the rate and possible control of sedimentation. After making the evaluation study of each project area, a separate report for each was submitted to the Corps by the State Conservationist, Soil Conservation Service, of the respective State. This report brings together the information in the separate project-area reports relative to anticipated changes in the agricultural economy as a result of proposed project development.

The objectives are to: (1) Present a physical inventory of the alluvial valley of the lower Mississippi River to depict its resources, physical characteristics, and its land and water problems as they relate to agricultural development, and to give some idea of agricultural production in the alluvial valley and its importance to the economy of each of the Delta States and the Delta Region as a whole; (2) describe the land and water problems in each project area and discuss the extent to which these problems could be overcome by construction of the proposed project; (3) describe the procedures and assumptions used by USDA in evaluating benefits, present the results and findings of its evaluation, and point out the major limitations of the procedures used and the limitations of the evaluation study.

The report is divided into two parts. In the first part, a discussion of the Delta in general, the data used are largely from secondary sources. No attempt was made to tabulate data in such a way that agricultural production could be estimated accurately for the entire Delta. To do so would have necessitated the tabulation of data by minor civil divisions lying entirely within the Delta in each State. In order to estimate the importance of agricultural production in the Delta relative to the total production in the Delta States, agricultural census data were tabulated for Arkansas, Louisiana, Mississippi, and Missouri. The Delta portion of these four States comprises 96 percent of the entire Delta. The production data tabulated for the Delta portion of these four States is not entirely accurate because entire Delta and part Delta counties and parishes were used in the tabulation. The data are sufficiently accurate, however, to permit an inference as to the importance of the Delta portion of the States to their economy as a whole. In addition to the agricultural data, the physiography, natural resources, trends in development of land and water resources, and land and water problems affecting agricultural development in the Delta are discussed.

The second part of the report deals with the evaluation made by USDA of the agricultural effects anticipated to result from the project proposed by the Corps. The procedures used in making the evaluation are presented. The project areas covered by the study, the land and water problems within each area, the proposed projects by areas, and the way in which each project would alleviate the problems are described.

The proposed project covers portions of the lower Mississippi River alluvial valley in Illinois, Missouri, Arkansas, Kentucky, Tennessee, Mississippi, and Louisiana. Areas within the Delta studied consisted of some of the major subbasins of the lower Mississippi River Basin, hill and tributary areas, backwater areas, and floodways, where proposed project works intended to provide for land development and water control were being studied by the Corps.

About 9,829,000 acres in the lower Mississippi alluvial valley were covered in the project study. This was exclusive of the hill-land areas studied. The number of acres included in the

survey in each of the major subbasins by States is given in table 1. Locations of the project areas studied are shown on the frontispiece.

TABLE 1.--Major subbasins and extent of areas studied, by States, lower Mississippi and Tributaries Study

State and major subbasin or project area	Area
	1,000 acres
Arkansas:	
St. Francis River Basin	1,237
L'Anguille River Basin	594
Cache River Basin	1,288
Big Creek Basin	673
Dials Creek Basin	30
Bayou Meto Basin	623
Boeuf-Tensas Basin	117
Total	4,562
Illinois:	
Mounds-Mound City	13
Kentucky:	
West Kentucky Tributaries	88

TABLE 1.--Major subbasins and extent of areas studied, by States, lower Mississippi and Tributaries Study--Continued

State and major subbasin or project area	Area
	1,000 acres
Louisiana:	
Boeuf-Tensas Basin	1,146
Red River Backwater	620
Atchafalaya River Basin	540
Total	2,306
Mississippi:	
Big Sunflower River Basin	274
Yazoo Headwater	564
Yazoo Backwater	883
Total	1,721
Missouri:	
New Madrid Floodway	117
St. Francis River Basin	239
St. Johns Bayou	99
Total	455
Tennessee:	
West Tennessee Tributaries	684
Total area studied	9,829

THE LOWER MISSISSIPPI DELTA

Physiography

The Mississippi Delta area is the alluvial plain of the lower Mississippi valley, extending from Cape Girardeau, Mo., to the gulf coast of Louisiana. It includes about 35,000 square miles of flood plain, 13,000 square miles of deltaic plain, and 15,000 square miles of loessial terraces.

From Head of Passes to Cape Girardeau, Mo., the Mississippi River stretches for about 1,000 miles. The alluvial plain is about 690 miles long. The deltaic plain, which begins below the head of the Atchafalaya River and extends in a great fan to the gulf, is about 310 miles long. The three divisions that make up the Mississippi Delta--the flood plain, the deltaic plain, and the loessial terraces--are collectively referred to in this report as the lower Mississippi alluvial valley.

The elevation of the alluvial valley ranges from mean sea level at the Gulf of Mexico to about 320 feet above mean sea level in Missouri. Loessial terraces rise 20 to 50 feet above the surrounding flood plain, which consists of low meander belts of ridges and intervening irregular flood basins. Ridges and basins of the upper part of the deltaic plain stand higher than the general surface and are more uniform than those in the alluvial plain. The lowlands between the ridges are often covered with water. These lowlands give way to coastal marshes and bays along the gulf. Loessial terraces--the portions of the alluvial fans of the tributary streams that are above the general level of the flood plain--are blanketed with loesslike deposits.

The lower Mississippi alluvial valley is flat throughout its length with an average gradient of about 0.5 foot per mile. The runoff from 41 percent of the area of the United States passes to the sea through this valley. The volume of water that passes through the valley varies greatly. At Arkansas City, Ark., river discharges range between 86,000 and 2,500,000 cubic feet per second. Banks and bed of the lower Mississippi River are easily eroded, and wide variations in discharge and lack of cohesion have created a meandering stream of constantly changing alignment.

The lower Mississippi runs close to the eastern wall of the alluvial valley, except from Memphis, Tenn., to Vicksburg, Miss., where it swings westward in a great arc. Thus the Yazoo-Mississippi Delta is the greatest of the alluvial subbasins of the lower Mississippi River Basin. Recent actions of the Mississippi indicate that the river now tends to move westward.

The bottom lands of the alluvial valley are broken by several upland areas, which rise like islands above the alluvial plain. Crowley's Ridge, the principal upland area, has a maximum elevation of about 150 feet above the surrounding lowlands and varies in width up to 10 miles. It is roughly parallel to the western escarpment of the valley and extends from the head of the valley to Helena, Ark. The ridge is cut by the channels of the St. Francis and L'Anguille Rivers.

The northwestern delta is cut also by Sikeston Ridge, a short, narrow highland lying to the east of the northern end of Crowley's Ridge. To the west of Crowley's Ridge, and parallel to it, is

Walnut Ridge, a low, poorly defined highland. Below the Arkansas River, Macon Ridge extends in a straight line from Eudora, Ark., to Sicily Island, La. Macon Ridge is considerably lower than Crowley's Ridge, but in many ways is similar, having well-defined, steep eastern bluffs with a very gentle, poorly defined western slope. Like several of the upland fragments in the Atchafalaya and Ponchartrain Basins, Sicily Island is an isolated circular highland, roughly 5 miles in diameter.

The alluvial valley of the lower Mississippi is made up of several drainage basins formed by the bluffs and ridges described and by the streams that flow directly into the Mississippi or its major tributaries. These major stream basins include the St. Francis, L'Anguille, and Cache Rivers; Big and Dials Creeks; Bayou Meto; Boeuf-Tensas-Macon; and the Atchafalaya and Big Sunflower Rivers. The lower Mississippi River Basin contains other major stream basins, but they were not included in the area studied.

Other streams and areas include New Madrid Floodway; Red River and Yazoo Backwater Areas; the Yazoo Headwater Area, which includes Big Sand Creek, Pelucia Creek, Hillside Floodway, Whiteoak Creek, McKinney Bayou, and Swan Lake; the West Tennessee tributaries, which consist of Obion, Forked Deer, Hatchie, and Tuscumbia Rivers (the latter partly in Mississippi); the West Kentucky tributaries, which include Mayfield and Obion Creeks, and Bayou du Chien; St. Johns Bayou in Missouri; and the Mounds-Mound City Area in Illinois.

The many streams within the lower Mississippi alluvial valley present problems, all concerned with land and water. All are caused by or result from the physical and topographic conditions within each stream drainage area or basin. Streams such as the hill-land tributaries, cause sedimentation problems; others, such as those in the exceedingly flat areas, have backwater-flooding problems; still others, and most stream basins within the alluvial valley, have drainage problems. Most of the major basins within the Delta have some combination of these problems. The problem of overwash and overflow from streambank flooding is common throughout the Delta.

Climate

The climate of the lower Mississippi alluvial valley is determined more by the extensive landmass of North America to the north and west and the tempering waters of the Gulf of Mexico to the south than by topography. The highest lands in the alluvial valley are only slightly more than 300 feet above sea level. Climatic conditions vary considerably from Cape Girardeau, Mo., at the northern end of the alluvial valley, to Burwood, La., at the mouth of the Mississippi River. At Cape Girardeau, temperature ranges from minus 26° F. to a high of 112° F. The frost-free period of the alluvial valley ranges from 182 days at Cape Girardeau to 353 days at Burwood. On the average, the first killing frost occurs at Cape Girardeau on October 16. Average date of the last killing frost in the spring at Cape Girardeau is April 17. Average annual precipitation in the valley ranges from 40.46 inches at Cairo, Ill., to 57.31 inches at Burwood, La. Table 2 gives a climatic summary for selected weather stations in the alluvial valley.

TABLE 2.--Climatic summary for selected weather stations

Station	Average dates of killing frost: Length of record	Average dates of killing frost: Last in spring	Average dates of killing frost: First in fall	Growing season	Length of record	Temperature: Maximum	Temperature: Minimum	Average precipitation: Length of record	Average precipitation: Annual
	Years	*Date*	*Date*	*Days*	*Years*	*° F.*	*° F.*	*Years*	*Inches*
Cape Girardeau, Mo.[1].	40	Apr. 17	Oct. 16	182	40	112	-26	33	44.41
Cairo, Ill...........	40	Mar. 29	Nov. 1	217	40	106	-16	40	40.46
Tiptonville, Tenn....	14	Mar. 23	Oct. 29	220	10	111	-8	14	50.27
Helena, Ark..........	35	Mar. 25	Nov. 1	221	29	111	-9	40	51.35
Greenville, Miss.....	40	Mar. 21	Nov. 5	229	40	110	-5	40	51.65
Burwood, La..........	30	Jan. 11	Dec. 30	353	30	99	10	31	57.31

[1] Killing frost and temperature data are for Jackson, Mo.

Source: Weather Bureau, U. S. Dept. Com.

Soils

Geology and hydrography

A brief history of the geology of the lower Mississippi River alluvial valley is necessary in order to properly understand the processes which produced such a large alluvial plain. The creation of this alluvial plain was the work of two great rivers, not one, as is generally assumed. The role the Ohio River played in the creation of this great valley was not generally understood until an intensive study of the geology of the valley was undertaken during World War II.[1]

This study traced in detail the courses of the Mississippi and Ohio Rivers for the past 6,000 years. The two rivers originally flowed parallel to each other, separated in the upper part of the valley by Crowley's Ridge and the Commerce Hills, which at one time formed a continuous ridge from the present site of Thebes, Ill., to Helena, Ark. At this time, the two rivers formed a junction near Simmsport, La. Subsequent junctions were formed near Natchez, Miss.; St. Joseph, La.; Vicksburg, Miss.; Tutweiler, Miss.; Memphis, Tenn.; and others, as the two rivers continued to meander and change courses.

The Mississippi River, receiving great volumes of runoff as the glaciers receded, cut through Crowley's Ridge at numerous places to join the Ohio River. The last cut-through was at Thebes, Ill., to form the Thebes Gap, through which the present-day river still flows.

During the last glacial period, when sea level was several hundred feet lower than it is now, the Mississippi and Ohio Rivers cut out deep valleys in the coastal-plain formation. During later periods of rising sea level, these valleys were refilled with sediment, giving rise to the present surface, the alluvial plain. The topography buried beneath the alluvium is rugged, some trenches being several hundred feet deep.

It has been estimated that the alluvial mass which partly fills the entrenched valley of the Mississippi River system has a volume of 1,000 cubic miles, exclusive of the sediment underlying the coastal marshes of Louisiana. In the relatively broad northern part of the alluvial valley, the alluvial deposit has an average thickness of 125 feet. The southern part of the valley is covered with an average of about 138 feet of alluvium. The maximum thickness of the alluvium in the northern section is 200 feet and in the southern section more than 350 feet.

The fine sands, silts, and clays of the present surface of the alluvium are underlain by gravel and coarse graveliferous soils. Borings in the alluvial mass show that there is a general, though irregular, gradation upward in the alluvium from coarse gravel and sand to the finer deposits of gravel and sand, and finally, near the surface, of silts and clays. In general, the quantity of gravel and coarse sand decreases as the gulf is approached.

The tendency of a mature river such as the Mississippi is to meander. This meandering of the Mississippi River is directly related to the soil-building process in the alluvial valley. Some idea of how this soil-building process has operated in the alluvial valley can be obtained from a study of the meander belt scars left throughout the valley by large and small streams. These streams moved, and continue to move, back and forth across the flood plain, depositing heavy loads of silt during high water. In the past, as at present, the streams of the alluvial valley have had great variations in the amount of water they carry. Under natural conditions the streams have periodically overflowed. Thus the larger streams have built high natural levees by the deposition of coarser materials along their banks during successive overflows. The occurrence of extensive areas of sandy soils near the Mississippi River is therefore easily explained.

The swiftness of the overflowing water determines the type of sediment that will be deposited. Rapidly moving water deposits the larger particles consisting of sand. As the velocity of the water is reduced, progressively smaller particles of fine sand and silt are deposited, and in quiet, or very slowly moving water, the finest particles consisting of clay are deposited. This soil pattern--sands near the stream, silts and fine sands a little further away, and clays still further away in the lower lying level areas--occurs throughout the entire alluvial valley of the Mississippi River.

Origin of deposits

The Mississippi River and its tributaries drains some 1,243,700 square miles in 31 States and two provinces of Canada. About 41 percent of the continental United States lies within the drainage basin of the Mississippi River. Soil material in any one location may have been transported from any State lying above it. This accounts for the complexity of the sediments from which the soils of the valley were formed.

The alluvial soils of the Mississippi River are differentiated from those of the smaller streams nearby partly because of their prevailingly darker color. This is probably due to the derivation of the Mississippi River alluvium, to a considerable extent, from the dark colored prairie soils of Iowa, Illinois, the Dakotas, Nebraska, Kansas, and small portions of Minnesota and Missouri. Considerable areas of reddish colored soils occur in Arkansas and Louisiana. These red soils owe their color chiefly to deposits derived from the Permian red beds of Texas, Oklahoma, and Kansas, and

[1] Fisk, H. N. Geological Investigation of the Alluvial Valley of the Lower Mississippi River. Corps of Engineers, War Dept. Dec. 1, 1944.

carried by the Arkansas and Red Rivers. In some instances, the red deposits cover the older dark deposits laid down by the ancient Mississippi River. In other instances, there are alternating layers of dark grey and red soils, as first the Mississippi River, then the Arkansas or Red Rivers deposited their sediments.

Alluvial soils

Recent alluvial soils are those which have been deposited by active streams in relatively recent times and have not been in existence long enough to have developed a true soil profile. They are neutral to alkaline in reaction and range in texture from coarse sands to heavy clays, with all the gradations of textures between the two extremes. The soils of the recent alluvium are generally associated with existing, or recently abandoned channels of the Mississippi River and its larger tributaries.

Low terrace alluvial soils are those which have been in existence long enough to develop a semblance of a soil profile. They are acid in reaction and in some cases are strongly acid, having pH values ranging from 6.5 to as low as 3. These soils are associated with very old natural levees along the ancient meander channels of the Mississippi River which are no longer active. They have been above overflow long enough for the soil to become leached and for the forces of nature to start the soil development process. These soils closely resemble the younger recent alluvial soils in location, use, productivity, color, and texture.

Loessial soils

The occurrence of fine aeolian deposits in, and immediately east of, the alluvial valley, plays an important part in the genesis of certain soils of the valley. The aeolian deposits, known as loess, are known to be deposits of dust brought in by the wind. Their greatest thickness is immediately east of the Mississippi alluvial valley, where they have been deposited, usually on coastal-plain material, to a depth of up to 50 feet. The depth decreases eastward until they finally disappear at a distance of about 100 miles. This lensing off of the loess deposits indicates an intimate relationship between the loess deposits and the alluvial valley. Fenneman states:[2]

> The close relation of the thickness and character of the loess mantle to the proximity of large south-flowing streams points to the flood plains of these streams as one of the immediate sources of the dust. As the prevailing winds in this latitude are from the west, the deposit is always more abundant on the east side. The ultimate source of the greatest body of loess was in some way connected with the Iowan ice sheet.

Important upland remnants with loess caps still remain in the alluvial valley. The most important is Crowley's Ridge, which extends discontinuously from Thebes, Ill., to Helena, Ark. Other remnants are the Bastrop Hills, Sicily Island, and the Marksville Hills.

The loessial uplands present a very serious siltation problem. Much of the loess is underlain by unconsolidated beds of sand and gravel, and when the mantle of loess is removed, the sands, especially, move downstream clogging and raising channel beds, and causing overflows and damage from siltation. The sediment problem is most acute in Mississippi.

The loessial terraces occupy some 15,000 square miles of the alluvial valley. The largest part of this area lies to the west of Crowley's Ridge in Missouri and Arkansas, indicating a close relationship between the upland remnant and the lower lying terrace. A smaller area of terraces lies immediately to the east of the ridge, and other areas lie to the south of it in Louisiana. These soils are older than the recent alluvium and low terraces of alluvial soils.

It is generally assumed that these terraces were built from Mississippi River sediments near the end of the glacial era, when the river was still flowing west of Crowley's Ridge. It follows, therefore, that these loessial terrace soils may be found in any location where the ancient Mississippi River once flowed. This may account for the occurrence of these soils in many parts of Louisiana at or near the elevation of the more recent alluvium. It may also explain the existence of loessial terraces on the east side of the present day Mississippi River.

The age of these loessial terrace soils coupled with their inherent poor drainage has caused excessive leaching, with the loss of iron, lime, and some phosphorus. Poor drainage, with the resulting waterlogged condition, has prevented oxidation of the soils, causing the general gray color of the soil.

Water

Streams and lakes

Drainage waters from 41 percent of the area of the United States flow through the alluvial valley of the lower Mississippi River. Besides the Mississippi itself, numerous streams, which are rivers in their own right, drain large upland areas and flow through the valley to reach the Mississippi. Such streams are the Yazoo River in Mississippi, the Red River in Louisiana, the Ouachita River in Arkansas and Louisiana, the Arkansas and White Rivers in Arkansas, and the St. Francis River in Arkansas and Missouri. Many smaller tributary streams enter the Mississippi River from the east, flowing through the Delta for short distances before joining the Mississippi. Examples are Bayou du Chien and Obion and Mayfield Creeks in Kentucky; and Obion, Forked Deer, Loosahatchie, and Hatchie Rivers in Tennessee. The Big Black and Homochitto Rivers in Mississippi also enter the Mississippi River from the east.

Streams of still another type in the Delta both originate and terminate within the alluvial

[2] Fenneman, N. M., Physiography of the Eastern United States, p. 510.

valley itself. Some of these are old abandoned stream channels of the Arkansas, Red, Mississippi, and Ohio Rivers. Examples are the Little River in Missouri and Arkansas, the Cache River and Big Creek in Arkansas; Bayou Bartholomew and the Boeuf-Tensas-Macon system in Arkansas and Louisiana; and the Big Sunflower River in Mississippi.

Still another type of stream in the basin is the distributary of the Mississippi River. The only active stream of this type is the Atchafalaya River in Louisiana. An inactive distributary is Steele Bayou in Mississippi.

The alluvial valley is generously supplied with rivers and streams. Not all streams are active, but even the inactive ones contain some usable water.

The supply of water in the streams in the Delta varies considerably. The maximum gaged flow of the Mississippi River at Vicksburg, Miss., was 2,080,000 cubic feet per second in 1937; the minimum gaged flow was 99,400 cubic feet per second in 1939. In the water-year of 1957 (Oct. 1, 1956, to Sept. 30, 1957) 414,100,000 acre-feet of water flowed past Vicksburg. The minimum recorded for any one water-year was 96,700,000 acre-feet in 1931. For the 29-year average, 1928-57, the flow was 405,000,000 acre-feet.

Many of the rivers in the alluvial valley furnish irrigation water to irrigators along their banks. The Ouachita River in Louisiana is probably the most widely used for this purpose chiefly because a minimum 6-foot channel is maintained for navigation. The major rivers in the Delta are never entirely dry and are therefore generally dependable sources of irrigation water. Water is readily available to farmers bordering the rivers, but it is physically feasible to divert water away from the rivers, making it available to farms other than those bordering the streams.

In addition to the streams and bayous, the Delta is abundantly supplied with lakes. Many oxbow lakes, representing old meander channels of the large streams, are found throughout the area. In general, there are fewer lakes in the northern part of the alluvial valley than in the central and southern portions. Some of the more important of these oxbow lakes are Horseshoe, Grand, and Old Town Lakes, and Lake Chicot in Arkansas; Lakes Providence, Bruin, and St. John, False River and Larto Lake in Louisiana; Moon, Eagle, and DeSoto Lakes, and Lakes Lee, Washington, and Swan in Mississippi.

In addition to these lakes, which are old meander channels of the Mississippi River, the hundreds of smaller oxbow lakes are old meander channels of rivers such as the Arkansas, the Red, the Ouachita, the St. Francis, and the Yazoo. These lakes are smaller than those along the Mississippi River, but they are important locally as sources of irrigation water and as recreation areas.

In Tennessee, the famous Reelfoot Lake is an important recreation area. This lake was formed in 1812 as the result of a subsidence caused by an earthquake.

In the lower end of the alluvial valley, Lakes Maurepas and Ponchartrain probably resulted from the subsiding of the land before the lower valley was settled. Lake Ponchartrain is a salt water lake and Lake Maurepas a fresh water lake.

Catahoula Lake in La Salle Parish, La., is an intermittent lake some 12 miles long and 3 miles wide when full. It fills during the winter when it is a duck hunter's paradise. In summer and early fall, the lake drains into the Ouachita River through Little River, and cattle graze on the lake bed.

The lower end of the Atchafalaya Basin is a maze of bayous, sloughs, lakes, and streams, all interconnected. These waters are noted for their fine fishing, hunting, and trapping. Many other lakes throughout the lower Mississippi Valley are famous as fishing and hunting grounds. Others are resort centers and recreation centers. Navigable rivers in the valley provide transportation for a tremendous tonnage of freight by barge and tow. Many rivers and lakes are used as sources of irrigation water for agriculture, and this use could be expanded by pumping and diversion. The general quality of water in the rivers that flow through the valley is good. Exceptions are waters of the Arkansas and Red Rivers.

Ground water

Generally speaking, ground water is abundant in the lower Mississippi alluvial valley. This abundance is due mainly to the way in which the sediments of the valley were laid down. Beds of sand and gravel underlie most of the surface of the valley. These beds vary in thickness but usually a dependable aquifer 40 feet thick lies at the bottom of the alluvial deposits. Shallow wells drilled to the base of the alluvium, with 40 feet of strainer at the lower end of the casing, produce large volumes of water suitable for irrigation and for domestic use. The water is hard and contains iron salts, which make it rather unpalatable, but the mineral content is not high.

In the alluvium of Mississippi an estimated 100 million acre-feet of water are stored in underground beds of sand and gravel. Although detailed reports are not available for other States in the alluvial valley, there is no reason to suspect that this condition does not exist also in other areas.

In much of the lower Delta, artesian water of high quality is available at depths of 1,000 to 1,500 feet. But because of the expense of drilling wells to this depth, this source of water is not likely to be developed for irrigation at any time soon.

Experience indicates that to date there has been an abundant supply of irrigation water within the Mississippi Delta. Farmers first began irrigation operations by utilizing surface waters (lakes and streams), but they soon found that a good supply of usable ground water could be obtained from relatively shallow depths. The recent trend has been toward the expanded use of ground water for irrigation. During the last decade hundreds of irrigation wells were installed throughout the alluvial valley in Arkansas, Mississippi, and northeastern Louisiana.

In the Delta part of Mississippi, 360 irrigation wells were in operation in 1954. Of the total, about 310 were used to irrigate rice and 50 were used to irrigate cotton, soybeans, corn, and pasture. By January 1955, there were 450 wells. At the end of 1955, more than 900 irrigation wells had been installed. Most of the new wells were used for supplemental irrigation of cotton and corn and for soybeans and pasture. Even with about 334,000 acre-feet of ground water used for irrigation in 1954 in the Delta portion of Mississippi, the water table was not appreciably lowered. The U.S. Geological Survey has 5 years of water-level records on about 40 observation wells in this part of Mississippi. The records show no serious lowering of the water table in any part of the area. They indicate that in the winter of 1957-58, the water table was higher than in any winter since the beginning of the record in 1953-54. This was despite considerable pumping during the intervening summers.

An exception to the abundance of ground water is the Grand Prairie rice-producing area of Arkansas. Here a serious cone of depression has developed in the water table because of continued irrigation of rice from wells. The ground water under the Grand Prairie area receives recharge from the White River, but the rate of recharge is not rapid enough to prevent declining ground-water levels. Another exception to the abundance of ground water is the rice-producing area in south Louisiana.

Forests

The forest resource is summarized here with specific reference to the natural or geologic Delta, as it occurs in Missouri, Mississippi, Arkansas, and Louisiana. The information is an appraisal of the forest resource, its area and composition, in both farms and commercial timber ownerships.

Area and extent of the forest resource

The Delta contains about 31 million acres of land. Forest occupy more than 11 million acres, or 36 percent of the region (table 3).[3] The rest of the area is chiefly agricultural.

[3]Survey units follow county rather than physiographic lines. The resulting overestimate of forest acreage is about equal to those portions of true Delta excluded in Mississippi below Warren County, in Tennessee, and in Kentucky. Species composition is representative except for pine.

TABLE 3.--Forest and nonforest land by survey regions, surveys made during period 1947-54

Region	Year of survey	Forest	Nonforest
	Year	*1,000 acres*	*1,000 acres*
Missouri............	1947	581	2,253
Mississippi.........	1947	2,043	3,422
Arkansas:			
North Delta.......	1950	1,477	3,216
South Delta.......	1950	2,021	2,669
Louisiana:			
North Delta.......	1954	2,172	1,375
South Delta.......	1954	2,827	6,882
Total...........		11,121	19,817

The distribution of woodland varies greatly. In the "battures," the exposed sides of the levees, at least 85 percent of the land is in forests and, in general, much of the best timber-growing soil occurs there. A generalized view of woodland density by counties is provided by figure 1. Note the clusters of counties that are less than 25 percent forested. Except for the South Delta of Louisiana, these clusters of counties represent predominately agricultural areas. In the South Delta, the lack of forest area is due mainly to the abundance of coastal marshes and natural prairies. Most counties that are more than 60-percent forested occur in areas subject to frequent flooding or in natural swamps. Despite the levee and drainage systems that have been developed, these areas are subject to backwater flooding when the Mississippi River is high. Because of the flood hazard, the areas have been more suitable for timber production than for farming. The backwater-flooding hazard has sharply delimited the extent to which these counties have been developed for purposes other than timber growing.

Composition of the forest

Except for a small proportion of cypress, Delta forests are almost entirely "hardwoods" or broadleaf species. Some shortleaf pine occurs on Crowley's Ridge and loblolly pine on Macon Ridge. In common with all forest lands east of the Great Plains, most have been almost completely cut over once and some have been several times. Despite past cuttings under poor cutting practices, Delta forests are comparatively productive; their recuperative power is tremendous.

A rich variety of hardwood species occurs in the Delta, but their typical association in stands may be conveniently classified into a few broad forest types. With minor exceptions, the characteristic species of the widely distributed mixed bottom land hardwood type are suitable for factory lumber, veneer, or cooperage. This

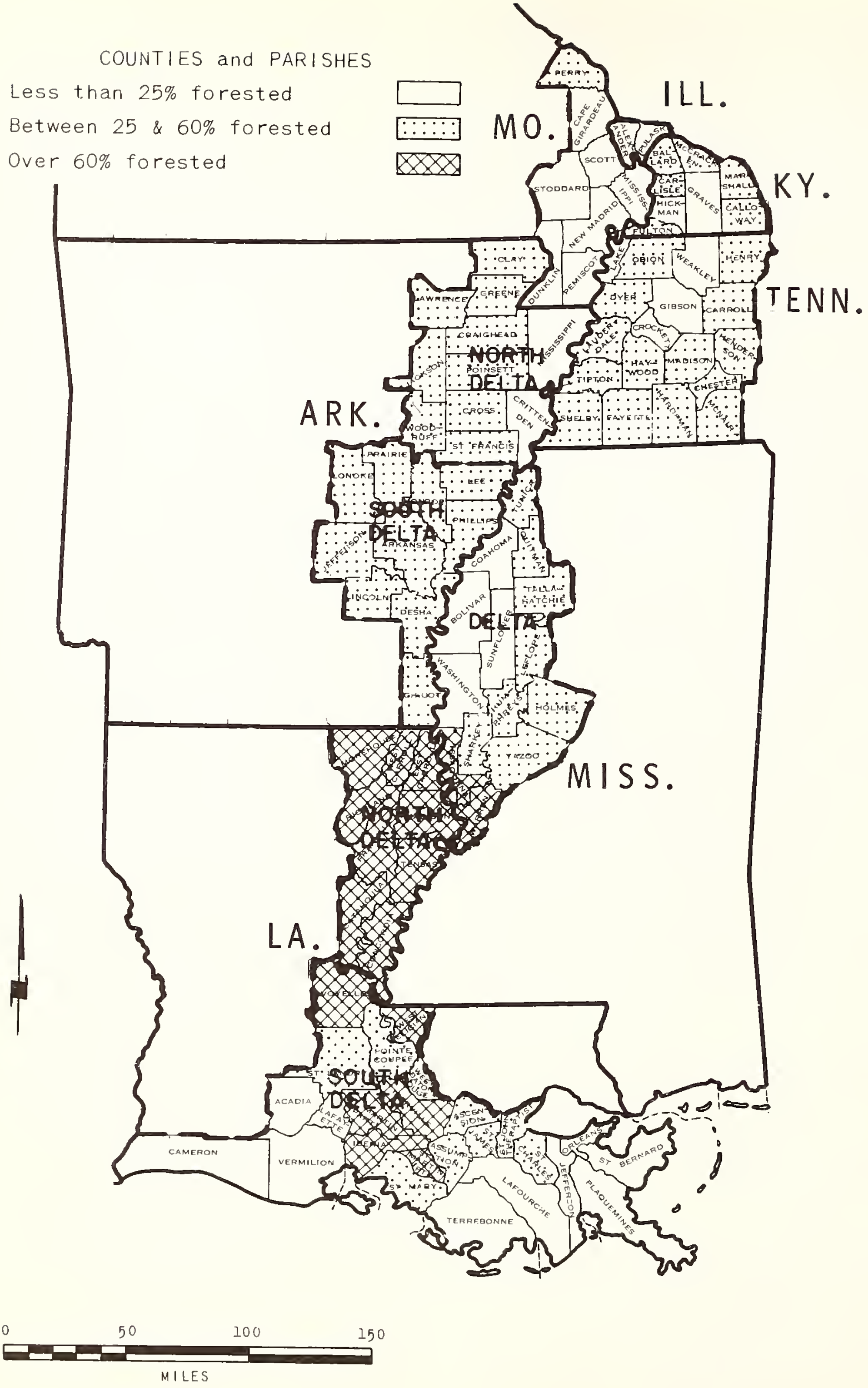


Figure 1.--Forest survey regions in the Mississippi Delta.

broad type embraces at least two significant subtypes. The sweetgum-water oak subtype occurs mainly on the modern flood plain formed by the present drainage system. Common associates include green ash, soft elm, hackberry, overcup oak, and pecan. The red oak-white oak-other hardwood subtype is variously characterized by cherrybark oak, cow oak, hickory, white ash, black gum, and winged elm. This latter type is found mainly on the older soil formations or terraces.

Cottonwood-willow is a fast-growing river-margin type of high utility. Although the two species may be associated, each is commonly found in pure stands. Cottonwood usually grows on the high sandy loam margins of streams or cutoff lakes, or on old fields in the bottoms. Willow characteristically grows on low banks along rivers or in shallow sloughs and swamps near the rivers.

Tupelo-cypress occurs mainly in the deep swamps and on the fertile but very heavy "buckshot" soils of low, wet flats and deep sloughs. Tupelo is frequently more abundant than cypress in heavily cutover stands. Pure stands of one species or the other prevail in some sections of the Delta. In the swamps around Lake Maurepas and Lake Ponchartrain in Louisiana, swamp black gum is a component of this type.

Overcup oak-bitter pecan occurs on the lower, poorly drained clay and silty clay flats of both first bottoms and terraces of the larger streams and in shallow sloughs. In the great backwater basins of the Yazoo and Red Rivers, these species are of little commercial value. The overcup oak is usually short-boled, limby, and infested with insects. Ring shake is a common defect in bitter pecan. Often associated with these species, however, is a workable nucleus of more desirable species, notably Nuttall oak and green ash. Toward the outer edges of the Delta and especially on the older geologic formations to the north, the overcup oak and pecan are of fair to good quality, with some excellent overcup in spots.

Uplands hardwoods of good quality are found on Crowley's Ridge in the Arkansas Delta and on the deep brown loam bluffs that flank the eastern margin of the geologic Delta. These stands are distinguished from corresponding phases of the mixed bottom-land oaks largely by the presence of yellow-poplar, beech, or pine. Some lower quality hardwoods, mainly upland oaks and hickory, are included in the upland fringes on dry sites.

Wildlife Resources

Game and fish are valuable recreational resources in the Delta as well as important commercial products. Large populations of deer, dove, quail, rabbit, turkey, waterfowl, and squirrel are found throughout the Delta. These species of game provide excellent hunting for residents of the respective Delta States and for thousands of out-of-State hunters.

Near Cape Girardeau, Mo., on the Illinois side of the Mississippi River, is one of the largest Canada goose wintering grounds in the United States. This area attracts hunters from all over the country. Combination farm-hunting clubs are scattered throughout the area. Goose hunting here has become an important source of income for many farmers, as well as for motels, restaurants, sporting-goods dealers, and other interests that cater to the sportsman.

Duck hunting throughout the rice-growing areas of Arkansas, Mississippi, and Louisiana attracts many thousands of duck hunters each year.

Such species as muskrat, beaver, otter, and nutria are heavily populated throughout the Delta but more in the lower Delta in Louisiana. In the lower Delta, trapping of these species is an important industry. In 1949-50, the number of pelts and furs trapped in Louisiana exceeded the total taken during the same year in Alaska and Canada combined.

Fish is also a valuable recreational and commercial resource. Bass, crappie, blue gill bream, catfish, buffalo fish, carp, and drum are common in Delta waters. In the coastal-gulf waters of Louisiana, shrimping is an important industry; Louisiana is the leading shrimp-producing State in the Union.

Commercial fishermen operate the full length of the lower Mississippi River, marketing their catches in the larger cities along the river and in inland areas as well.

Minerals

Mineral production is not an important source of income in the Delta, although Arkansas, Louisiana, and Mississippi derive much of their income from minerals. Most of the total value of mineral production in these States comes from petroleum and natural gas. In general, however, oil production in all Delta States is outside the Delta. There are a few oil wells in the Delta counties of Mississippi and some oil is produced in the extreme lower end of the Delta in Louisiana, but the amount produced in relation to total production in these States is negligible. No oil is produced in the Delta portions of Arkansas and Missouri, but in Arkansas oil production in areas outside the Delta is considerable.

The Delta has some clay suitable for manufacture of tile, roofing tile, structural tile, fireproofing, and light aggregate for concrete. A few plants in the Delta now manufacture a new type of tile block for building construction, in which the main ingredient is Delta clay.

A few small deposits of sand suitable for production of glass have been discovered in the Delta, but usually they were in such small quantities and so poorly assorted as to be of little value.

Sulfur and salt have been found in the Delta portion of Louisiana in such quantities as to make it economically feasible to mine these minerals. Sulfur and salt mining are fairly well-developed industries in localized areas of the Atchafalaya River Basin in Louisiana.

High grade bauxite ore is in Mississippi and in sufficient quantities in Arkansas as to be one of the leading industries of the State. None of the bauxite, however, is located in the Delta.

Population

In 1950, the population of counties and parishes lying wholly or partly within the Delta in Arkansas, Kentucky, Louisiana, Mississippi, Missouri, and Tennessee was 2,105,156, of which 1,749,135, or about 83 percent was listed as rural. In 1940, the Bureau of the Census reported a population in these areas of 2,417,171, of which 1,856,130, or about 77 percent, was rural. From 1940 to 1950, population in Delta counties and parishes declined by about 13 percent and rural population by about 6 percent. In 1950, the population census of the 6-State area was 16,963,118, of which 7,445,166, or about 44 percent, was rural.

The total civilian labor force in the Delta in 1950 was reported to be 832,092, of which 91 percent were employed and 9 percent unemployed. Of the total civilian labor force, 333,362, or about 40 percent, were employed in agriculture. The civilian farm labor force showed a considerably lower rate of unemployment, with only 2 percent unemployed. In 1950, the farm labor force consisted of 58 percent farmers, 9 percent unpaid farmworkers, 16 percent paid farmworkers, 15 percent others employed in agriculture, and 2 percent unemployed.

THE AGRICULTURAL INDUSTRY

The low, flat alluvial plain built up by the lower Mississippi River and its tributaries constitutes a distinct physiocultural region. Its soil and water resources and its long-growing season make the region ideal for production of cotton, corn, and rice, among other crops, and for the growth of valuable forest species native to the alluvial valley. The region now supports one of the most dense populations of any agricultural area of comparable size in the Nation, but it is physically capable of supporting an even denser population.

Although the lower Mississippi alluvial valley, along with many other sections of the country, has had a rather phenomenal industrial growth since World War II, its economy is still primarily agricultural. It is dominated largely by cotton production and by the plantation system.

Within the alluvial valley, flooding combined with variations in soils, elevation, and drainage has given rise to variations in the land-utilization patterns and types of farming throughout the region.

The data concerning the agricultural economy as presented here were compiled from U.S. Census of Agriculture reports. For convenience in compiling data, the boundary of the alluvial valley follows county and parish lines. Thus, data from several part-Delta counties and parishes were included in the tabulation.

Counties and parishes lying wholly or partly within the Delta in Arkansas, Louisiana, Mississippi, and Missouri make up 96 percent of the Delta area. Therefore, in order to get a land-area representative of the Delta for purposes of analyzing agricultural census data, entire and part-Delta counties and parishes of these four States were used. This area also assures more uniformity in analysis of data, as it is essentially the same area used by the U. S. Forest Service to obtain forestry data in the Delta portion of these four States.

Major Land Use

Some 11 million acres, or about 36 percent of the total land area of the Delta, are forested. This forested area includes all types of ownership. A little more than 19 million acres, or about 63 percent of the area, is in farms. Of the 19 million acres included in farms, about 24 percent is in farm woodland. About 85 percent of the open land in farms is used for cropland; 9 percent is used for pasture (other than cropland pasture and woodland pasture); and 6 percent is in other open land uses. Other major uses of land in the alluvial valley include watered areas, urban areas, State parks, and federally owned land other than national forests.

With land clearing a continuous process, the major land use of the lower Mississippi Valley is constantly changing. As timbered areas are cleared, the amount of open land increases at the expense of the woodland acreage. Large timber interests are always seeking desirable timbered sites to add to their holdings. When such purchases are made, the acreage of land in farms is correspondingly reduced. The whole process of land conversion, and in some areas of the Delta, reversion keeps the major land use throughout the Delta in a state of constant change.

Types of Farming

For purposes of analysis, the type-of-farming classifications used by the Bureau of the Census is used in this report. The Bureau of the Census grouped all commercial farms into types of farming as follows:[4] (1) Cash-grain farms--farms in which sales of corn, sorghum, small grains, field peas, field beans, cowpeas, and soybeans amount to 50 percent or more of the value of all products sold on the farm; (2) cotton farms--on which the sale of cotton makes up 50 percent or more of the value of all products

[4] U.S. Census of Agriculture, 1954.

sold on the farm; (3) other crop farms--include other field-crop farms producing peanuts; Irish potatoes; sweetpotatoes; tobacco; sugarcane; fruit and nut farms producing berries, other small fruits, tree fruits, grapes and nuts; and general farms primarily producing crops; (4) livestock farms--including dairy farms, poultry farms, and general farms producing primarily livestock; (5) crop and livestock farms--this type of farming contains those that could not be classified as either crop or livestock farms, but on which the sale of all crops amounted at least to 30 percent but less than 70 percent of the total value of all farm products sold on the farm; (6) miscellaneous farms--include those farms that had 50 percent or more of the total value of products accounted for by the sale of horticultural products, horses, or forest products.

The 1954 Census of Agriculture shows that 63 percent of all land in farms in the Delta was in cotton farms. Of all land in farms, 12 percent was in cash grain farms in 1954; 11 percent in livestock farms; 4 percent in other crop farms; 2 percent in crop and livestock farms; and 8 percent in miscellaneous farms. The percentage of land in farms contained in each type of farm within each of the Delta States and for the Delta as a whole is shown in figure 2.

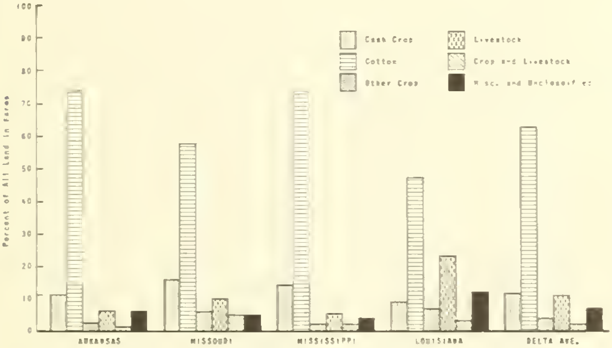


Figure 2.--Distribution of types of farming in the Mississippi Delta by States.

All types of farms in the Delta portion of Louisiana have higher percentages of woodland than those in the rest of the State. Missouri, which is better developed agriculturally than the other Delta States, has the smallest percentage of all land in woodland on all types of farms. The major use of land in farms by type of farming in each of the Delta States in 1954 is shown in figures 3 to 6.

Size of Farms

In 1954, the average size of farm in Delta States in the lower Mississippi alluvial valley was 86 acres (fig. 7). Farm size varies by type of farm from an average of 47 acres for miscellaneous farms to 371 acres for cash-grain farms. Although this range in average size of farm by type of farming is true for the Delta as a whole, size of farm varies widely by type between the States. In Arkansas, cash-grain farms are largest, followed by other crop, livestock, crop and livestock, cotton, and miscellaneous farms. In Missouri, other crop farms are largest, followed by crop and livestock, livestock, cotton, and miscellaneous farms. In Mississippi, other crop farms are largest, followed by crop and livestock, cash crop, livestock, cotton, and miscellaneous farms. In Louisiana, crop and livestock farms are largest, followed by livestock, cash crop, other crop, cotton, and miscellaneous farms.

Farms in the Delta, as in most parts of the United States, have steadily increased in average size, increasing from 51 acres in 1940 to 86 acres in 1954 (table 4).

TABLE 4.--Average size of farm, and percentage increase in size, Mississippi Delta States, selected years, 1940-54[1]

Item	Delta portion of--				Delta
	Arkansas	Missouri	Mississippi	Louisiana	
Farm size:	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*
1940..........	52	90	42	47	51
1945..........	56	89	46	61	58
1950..........	73	97	57	71	70
1954..........	93	117	71	84	86
Increase in size:	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
1940-45.......	8	-2	11	30	14
1945-50.......	30	9	22	17	20
1950-54.......	27	21	26	18	23

[1] U.S. Census of Agriculture.

As shown in table 4, the percentage of change in size of farms by 5-year periods has not been uniform throughout the Delta.

Farms having more than 1,000 acres per farm account for 29 percent of all land in farms in the Delta. A total of 43 percent of all land in farms in the Delta is contained in farms having more than 500 acres per farm. Farms ranging from 220 to 499 acres account for 16 percent of all land in farms; 22 percent of the farmland is contained within farms having 70 to 219 acres; and 19 percent of the land is in farms containing less than 69 acres. Table 5 shows the percentage of all land in farms by size of farm, by States, and for the Delta average.

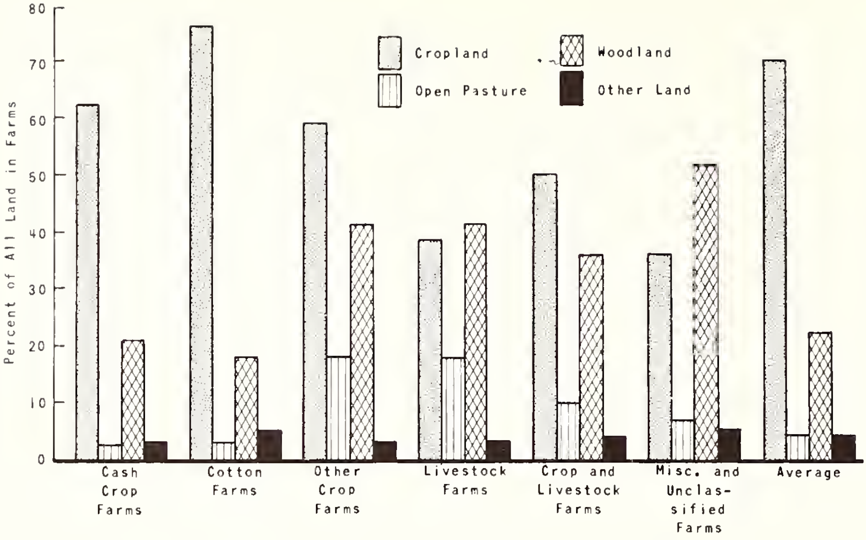


Figure 3.--Major use of land in farms by type af farm in the Mississippi Delta in Arkansas, 1954.

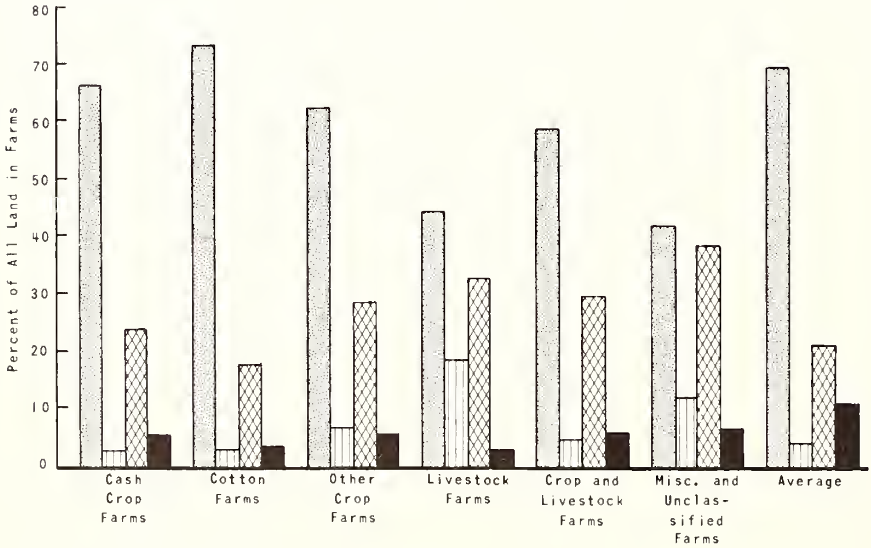


Figure 4.--Majar use af land in farms by type of farm in the Mississippi Delta in Mississippi, 1954.

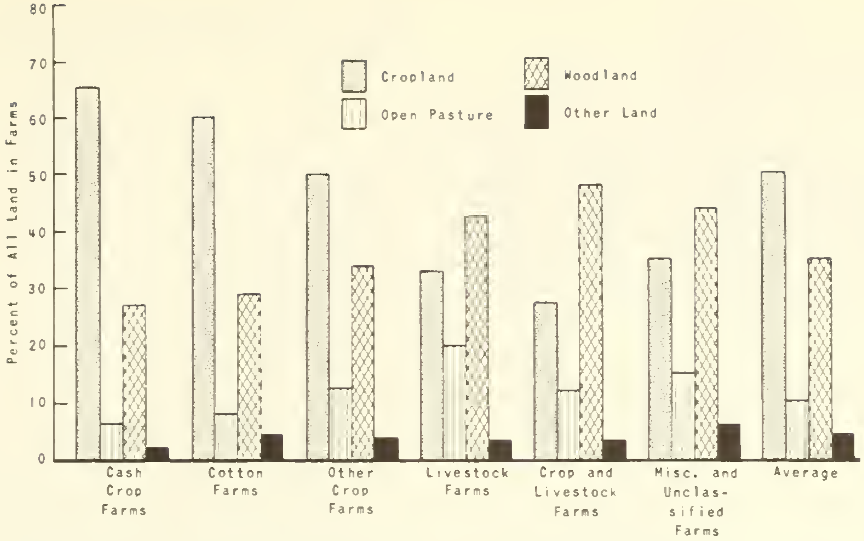


Figure 5.--Major use of land in farms by type of farm in the Mississippi Delta in Louisiana, 1954.

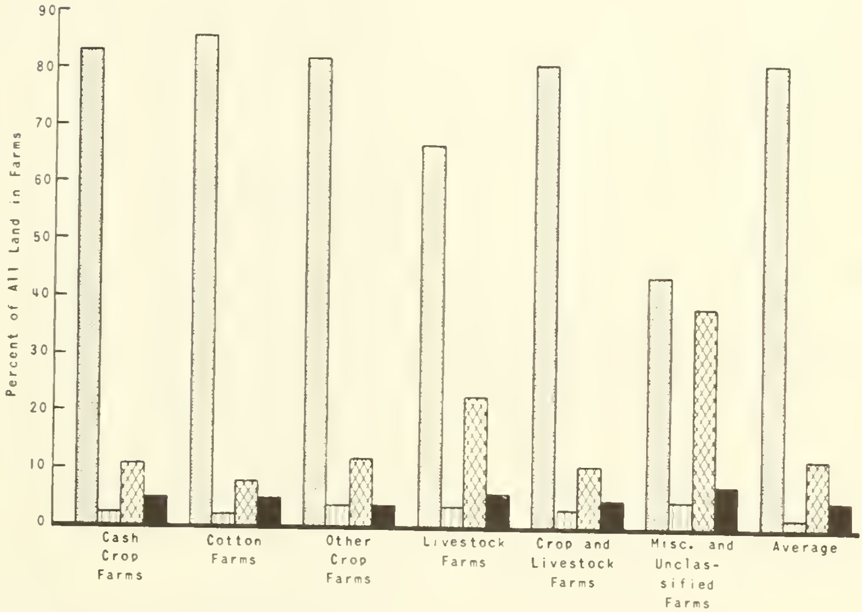


Figure 6.--Major use of land in farms by type of farm in the Mississippi Delta in Missouri, 1954.

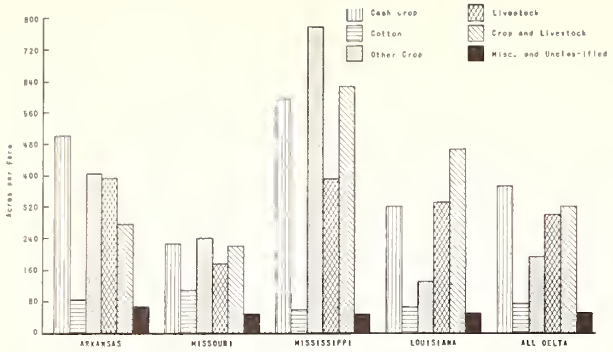


Figure 7.--Average size of farm by type of farming--Mississippi River Delta--by States.

TABLE 5.--Percentage of land in farms by size of farm, Mississippi Delta States, 1954[1]

Size of farm (acres)	Delta portion of--				Delta
	Arkansas	Missouri	Mississippi	Louisiana	
	Percent	*Percent*	*Percent*	*Percent*	*Percent*
Less than 69.....	17	11	21	25	19
70 to 219........	20	42	12	20	22
220 to 499.......	17	27	12	11	16
500 to 999.......	15	11	18	11	14
More than 1,000..	31	8	37	34	29

[1] U.S. Census of Agriculture.

Land Tenure

The largest portion of all farms in the Delta is operated by tenants. Throughout the Delta States, an average of 72 percent of the farms are tenant-operated (table 6). Only 33 percent of all land in farms, however, is operated by tenants.

Of all farms operated by tenants, the largest percentage is operated by sharecroppers; it accounts for 66 percent of all rented farm units in the Delta. Share-cash tenants operate the largest percentage of all rented land, accounting for 40 nercent of all land operated by tenants.

Of all farm units in the Delta States, about 8 percent are multiple units. These multiple units are composed of subunits, of which 82 percent are operated by sharecroppers. The multiple units contain 40 percent of all land in farms in the Delta. Of all land in the multiple units in the Delta, 82 percent is operated by croppers. The land in multiple units operated by croppers accounts for 92 percent of all Delta land operated by croppers.

TABLE 6.--Tenure status of farmers, Mississippi Delta States, 1954[1]

Item	Arkansas	Missouri	Mississippi	Louisiana	Delta States
Percent of all farms operated by:	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Full owners...	15	25	11	27	18
Part owners...	10	16	5	14	10
Managers......	(2)	(2)	(2)	(2)	(2)
Tenants.......	75	59	84	59	72
Percent of all land in farms operated by:					
Full owners...	27	27	31	34	30
Part owners...	27	26	26	29	27
Managers......	10	1	13	14	10
Tenants.......	36	46	30	23	33
Percent of all tenants who are:					
Cash tenants..	4	2	3	4	4
Share-cash tenants.......	4	8	1	2	2
Crop-share tenants.......	23	45	10	49	26
Livestock-share tenants.	(2)	3	(2)	(2)	(2)
Croppers......	67	40	84	41	66
Unspecified tenants.......	2	2	2	4	2
Percent of all tenant-operated farmland operated by:					
Cash tenants..	14	4	24	11	13
Share-cash tenants.......	10	12	4	3	8
Crop-share tenants.......	38	55	19	55	40
Livestock-share tenants.	(2)	10	(2)	2	3
Croppers......	30	15	48	23	30
Unspecified tenants.......	8	4	5	6	6
Farmland operated by white farmers:					
As percentage of all farmland	82	87	79	86	85
Percentage operated by:					
Full owners.	27	30	36	42	34
Part owners	32	26	31	29	30
Managers....	12	1	16	13	11
Tenants.....	29	43	17	16	25

See footnotes at end of table.

TABLE 6.--Tenure status of farmers, Mississippi Delta States, 1954[1]--Continued

Item	Arkansas	Missouri	Mississippi	Louisiana	Delta States
Farmland operated by nonwhite farmers:	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
As percentage of all farmland	18	3	21	14	15
Percentage operated by:					
Full owners.	26	23	17	21	21
Part owners.	18	11	9	13	13
Managers....	1	(2)	(2)	6	2
Tenants.....	55	66	74	60	64

[1] U.S. Census of Agriculture.
[2] Less than 1 percent.

Of all land in farms in the Delta, 85 percent is operated by white operators and 15 percent is operated by nonwhite operators. Full owners account for 34 percent of all land operated by white operators. The next largest group of white operators is the part-owner group, which accounts for 30 percent of all land operated by white operators.

The percentage of land operated by nonwhite operators that is owned by full- and part-owners is much lower than that for the white operators. Of the land operated by nonwhite operators, 64 percent is operated by tenants.

Crops and Livestock

Of all land in farms in Arkansas, Louisiana, Mississippi, and Missouri, 22 percent lies in the Delta. The percentage that total land in farms lying in the Delta is of total land in farms in the States, ranges from 6 percent in Missouri to 46 percent in Louisiana. Of the total cropland in the four States, 30 percent is in the Delta. The percentages of total cropland in the States that are in the Delta range from 9 percent in Missouri to 53 percent in Arkansas. Of all woodland in farms in the four States 16 percent is in the Delta. The percentage ranges from 3 percent in Missouri to 40 percent of all woodland in farms in Louisiana. The percentages of land distribution within the States are shown in tables 7, 8, and 9.

In order of importance, the principal crops grown in the Delta are cotton, soybeans, corn, rice, and oats (table 10). These crops occupy 84 percent of all cropland harvested. The remaining cropland is used for pasture, hay, and miscellaneous crops. More than half of the acreage of cotton, soybeans, and rice harvested in the four States is harvested in the Delta.

Of all major crops produced on the harvested acreage, 54 percent of all soybeans; 72 percent

TABLE 7.--Land in farms: Total acreage and acreage and percentage in Delta area, Mississippi Delta States, 1954[1]

State	Acreage in-- State	Acreage in-- Delta area	Percentage in Delta area
	1,000 acres	*1,000 acres*	*Percent*
Arkansas..........	17,944	6,793	38
Louisiana........	11,441	5,268	46
Mississippi......	20,702	4,335	21
Missouri.........	34,195	2,019	6
4 Delta States.	84,282	18,415	22

[1] U.S. Census of Agriculture.

TABLE 8.--Cropland: Total acreage, and acreage and percentage in Delta area, Mississippi Delta States, 1954[1]

State	Total cropland in State	Total cropland in Delta	Percent in Delta
	1,000 acres	*1,000 acres*	*Percent*
Arkansas.........	8,811	4,651	53
Louisiana........	5,468	2,771	51
Mississippi......	7,792	2,676	34
Missouri.........	17,705	1,643	9
4 Delta States.	39,776	11,741	30

[1] U.S. Census of Agriculture, 1954.

TABLE 9.--Woodland in farms: Total acreage and percentage in Delta area, Mississippi Delta States, 1954[1]

State	Total woodland in farms in State	Total woodland in farms in Delta	Percent in Delta
	1,000 acres	*1,000 acres*	*Percent*
Arkansas.........	6,534	1,578	24
Louisiana........	3,949	1,579	40
Mississippi......	8,877	1,163	13
Missouri.........	8,585	237	3
4 Delta States.	27,945	4,557	16

[1] U.S. Census of Agriculture, 1954.

TABLE 10.--Principal crops harvested, total acreage, and percentage in Delta area, Mississippi Delta States, 1954[1]

Item	Acreage in-- State	Acreage in-- Delta area	Percentage in Delta area
	1,000 acres	*1,000 acres*	*Percent*
Cotton:			
Arkansas.........	1,698	1,394	82
Louisiana........	672	414	62
Mississippi......	1,948	975	50
Missouri.........	424	421	99
4 Delta States.	4,742	3,204	68
Soybeans:			
Arkansas.........	957	819	86
Louisiana........	72	68	87
Mississippi......	507	458	90
Missouri.........	1,701	512	30
4 Delta States.	3,237	1,857	57
Corn:			
Arkansas.........	559	316	56
Louisiana........	557	344	62
Mississippi......	1,534	224	15
Missouri.........	2,839	273	10
4 Delta States.	5,489	1,157	21
Rice:			
Arkansas.........	671	636	95
Louisiana........	666	345	52
Mississippi......	74	71	97
Missouri.........	6	5	88
4 Delta States.	1,417	1,057	75
Oats:			
Arkansas.........	347	224	65
Louisiana........	107	69	65
Mississippi......	328	221	67
Missouri.........	1,306	19	1
4 Delta States.	2,088	533	25

[1] U.S. Census of Agriculture, 1954.

of all cotton; 19 percent of all corn; 29 percent of all oats; and 88 percent of all rice produced in the four States are produced in the Delta. Table 11 gives the total production of each crop on the acreage harvested and the quantity produced in the Delta, by States.

Of all cotton produced in the United States in 1954, 21 percent was produced in the Mississippi Delta on 17 percent of the total cotton acreage harvested in the United States. Of all rice harvested in the United States in 1954, 49 percent was produced in this region on 44 percent of the total rice acreage harvested in the United States. The region also accounted for 7 percent of all soybeans in the United States on 12 percent of the total soybean acreage harvested.

Crop sales in the Delta part of the four States accounted for 64 percent of the total value of crops sold in these States in 1954

TABLE 11.--Production of specified crops: Total amount, and amount and percentage in Delta area, Mississippi Delta States, 1954[1]

State	Production in-- State	Production in-- Delta area	Percentage produced in Delta area
	1,000 bales	*1,000 bales*	*Percent*
Cotton:			
Arkansas.........	1,294	1,147	89
Louisiana........	540	358	66
Mississippi......	1,548	835	54
Missouri.........	406	404	100
4 Delta States.	3,788	2,744	72
	1,000 bu.	*1,000 bu.*	
Soybeans:			
Arkansas.........	10,584	9,551	90
Louisiana........	1,165	1,108	95
Mississippi......	5,040	4,480	89
Missouri.........	23,596	6,699	28
4 Delta States.	40,385	21,838	54
Corn:			
Arkansas.........	6,448	4,228	66
Louisiana........	10,793	6,582	61
Mississippi......	25,165	3,800	15
Missouri.........	66,254	6,000	9
4 Delta States.	108,660	20,610	19
Oats:			
Arkansas.........	14,775	10,377	70
Louisiana........	3,526	2,434	69
Mississippi......	12,946	9,397	73
Missouri.........	48,509	709	1
4 Delta States.	79,756	22,917	29
	1,000 cwt.	*1,000 cwt.*	
Rice:			
Arkansas.........	40,039	38,265	96
Louisiana........	10,084	5,402	54
Mississippi......	4,311	4,155	96
Missouri.........	375	344	92
4 Delta States.	54,809	48,166	88

[1] U.S. Census of Agriculture, 1954.

(table 12). Values range from 39 percent of all crop sales in Missouri to 88 percent in Arkansas.

As is evident from table 12, more than half of all crop sales in the four States comes from the Delta, which accounts for only 30 percent of all cropland in the four States.

Of the $12 million worth of forest products sold on farms in the four States, $1.4 million, or about 12 percent, is from the Delta.

Livestock enterprises are less important in the Delta than in areas of the four States outside the Delta. Livestock accounts for 7 percent of the total value of farm products sold in the Delta compared with 37 percent of the total value of farm products sold in the four States as a whole. The percentage of the total value

TABLE 12.--Crops sold: Total value, and value and percentage in Delta area, Mississippi Delta States, 1954[1]

State	Value of crops sold in--		Percentage in Delta area
	State	Delta area	
	1,000 dollars	*1,000 dollars*	*Percent*
Arkansas........	377,186	331,189	88
Louisiana.......	240,000	160,847	67
Mississippi.....	351,312	193,770	55
Missouri........	269,936	105,428	39
4 Delta States	1,238,434	791,234	64

[1] U.S. Census of Agriculture, 1954.

of farm products sold that is accounted for by sales of livestock and livestock products in the Delta part of these States ranges from 2 percent in Missouri to 36 percent in Louisiana. In Arkansas, 14 percent and in Mississippi, 12 percent of the total value of livestock and livestock products sold comes from the Delta.

Of the livestock on farms in the four States, 17 percent of all cattle, 23 percent of all horses and mules, 14 percent of all hogs, 7 percent of all sheep, and 3 percent of all chickens on farms are in the Delta portions of the States. The percentage of the total of each kind of livestock on farms that is in the Delta part of each State is shown in table 13.

In 1954, the total value of farm products sold in the Delta part of the four State area was $854.7 million, which was 43 percent of the total value of farm products sold in the entire area. Crop sales accounted for 93 percent of all farm products sold in the Delta, livestock and livestock products sales accounted for 7 percent, and forest product sales accounted for less than 1 percent.

TABLE 13.--Livestock on farms in the Delta area as a percentage of total livestock on farms, Mississippi Delta States, 1954

Kind of livestock	Arkansas	Louisiana	Mississippi	Missouri	Total Delta area
	Percent	*Percent*	*Percent*	*Percent*	*Percent*
Cattle...........	25	43	15	3	17
Horses and mules.	32	51	14	4	23
Hogs.............	42	52	24	4	14
Sheep............	18	30	37	([1])	7
Chickens.........	2	13	2	2	3

[1] Less than 1 percent.

THE FOREST INDUSTRY

Forest-Land Ownership

Of the Delta woodlands, 96 percent are in private ownership (table 14). The 18 percent held by the forest industries and public agencies is dedicated indefinitely to timber growing. To be sure, much of the public land is managed for game production and as part of the water-control program, but timber is also grown. In the classification used in table 14, which shows "farm" and "other" private land classes, the classification is based on the primary occupation of the owner. Thus, much land of the "other" class is held in parts of farms, but its owner may be a merchant or professional worker in a nearby town or city. Also, considerable "other" acreage is held for investment purposes, and the ultimate use of these forests is probably more responsive to economic forces than is true of other types of ownership.

TABLE 14.--Distribution of forest land by type of ownership, Mississippi Delta, surveys made during period 1947-54

Ownership class	Forest area	
	Million acres	*Percent*
Public lands.............	0.4	4
Private lands:		
Farm....................	4.2	38
Forest industry.........	1.6	14
Other...................	4.9	44
All forest land.......	11.1	100

Timber Volume

The volume of wood in the Delta in sound, well-formed trees at least 5.0 inches in diameter (4.5 ft. from the ground) is 8 billion cubic feet (122 million cords). Not included in this estimate is an additional 1.8 billion cubic feet (27 million cords) of sound material in cull trees. Because of excessive rot, roughness, poor form, or other defect, these trees are unmerchantable, either now or prospectively, for veneer, factory lumber, or use in other high-quality products. With increasing markets for wood-fiber products, some of the timber, can be utilized for pulpwood. For example, cull-tree volume in soft-textured hardwoods

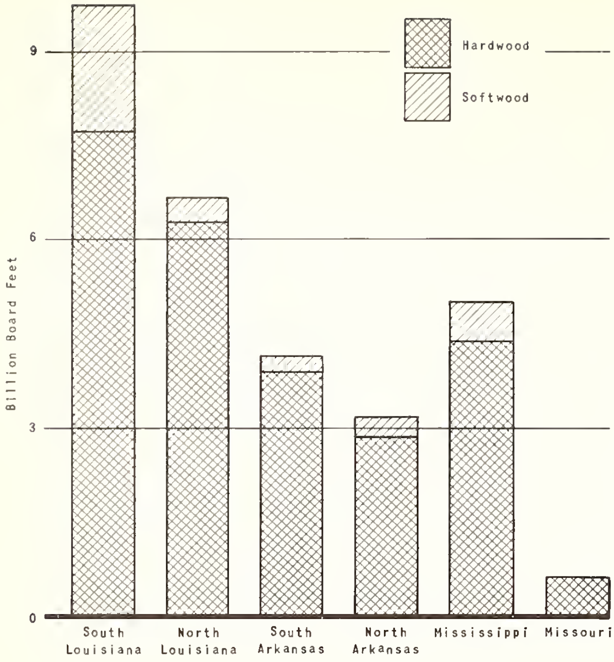


Figure 8.--Sawtimber volume by Delta survey regions.

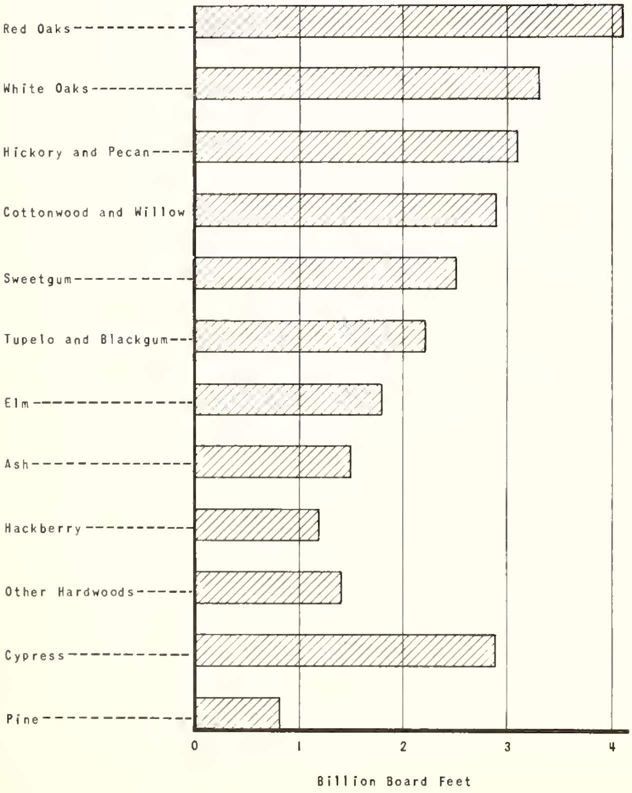


Figure 9.--Sawtimber volume by species.

generally acceptable for pulping totals 7 million cords, while the oaks are now coming into use. Most of the timber in these cull trees could serve for fuelwood or other farm use.

Sawtimber stock amounts to 25 million board feet of hardwoods and nearly 4 billion of softwoods, chiefly cypress. This tally includes hardwoods at least 12 inches in diameter and softwoods of not less than 10 inches.

Ordinarily, industrial hardwood sawtimber is cut from trees 16 inches and larger. In these size classes are 17 billion board feet, or some 70 percent of all hardwood sawtimber.

Figure 8 shows the distribution of sawtimber by region and figure 9 by species groups. Oaks, gums, and cottonwood-willow account for 55 percent of the volume and for even more of the value. These, as well as minor species, achieve optimum development in the Delta and are highly prized for use in hardwood-timber products.

Timber Cut

More than half of the Nation's annual cut of cottonwood, willow, and gum lumber comes from the Delta. For such species as hackberry, persimmon, and pecan, the Delta is the primary source of raw material. With less than 5 percent of the Nation's hardwood acreage, the Delta supplies about 15 percent of the hardwood lumber produced.

In 1954, logging removed more than 260 million cubic feet of timber from the Delta. About 90 percent of this was cut from sawtimber-size trees.

Information from severance-tax reports and other sources suggests that the total annual cut has been relatively stable since 1946. It has varied from a high of about 290 million cubic feet in 1948 to a low of some 240 million cubic feet in 1949. During the last decade the average annual cut was roughly 280 million cubic feet.

The chief industrial use of wood is in sawlogs for lumber products, which make up nearly half of the annual timber cut (fig. 10).

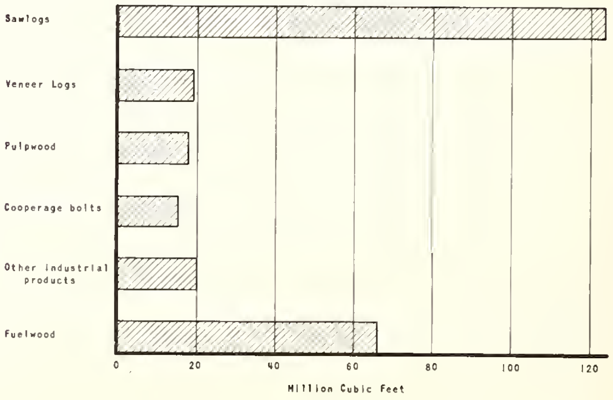


Figure 10.--Annual timber cut by products.

In the Delta most of the lumber is produced by large operators. In Mississippi, for example, it is estimated that fully 90 percent of the lumber is sawn at mills, each of which processes several million board feet annually.

Although its use is declining, fuelwood accounts for nearly a fourth of the growing stock cut. The rest of the annual cut is mainly industrial wood, largely veneer, cooperage, and pulpwood.

In recent years, the quantity of hardwood cut for pulp has increased markedly. Virtually all of it still comes from the soft-textured gums, cottonwood, and willow. In 1946, production of Delta hardwoods for pulping totaled 67,000 cords. By 1954, hardwood pulp production climbed to 188,000 cords. In 1956, it rose to 246,000 cords (fig. 11), and the rise is continuing. Pulpwood mills that draw wood from the Delta are increasing their capacities and broadening their use of species. A new mill is under construction in the South Delta of Arkansas, another in the South Delta of Louisiana, with still another planned for that area.

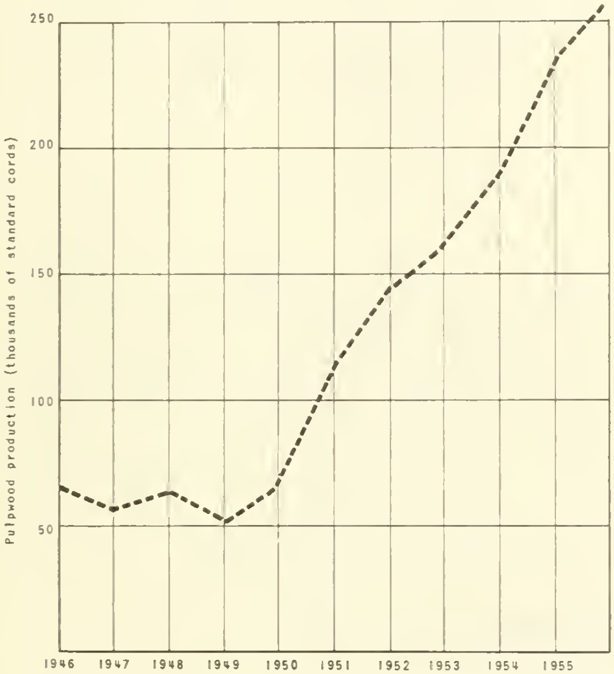


Figure 11.--Delta hardwood pulpwood production.

Research by the U. S. Forest Products Laboratory at Madison, Wis., has developed the semichemical and cold-soda hardwood pulping processes now being used in the South. These processes yield pulps which, when blended with pine pulps, create improved products. Blending permits more efficient manufacture of paper for particular uses. The potentialities in blending suggest wider use of hardwood timber. Further increases in the use of Delta hardwoods for pulp seem certain.

The upsurge in hardwood pulping has created a market for timber that formerly was used only for fuel or other farm needs. The overall effects bear stressing. The revenues possible from timber growing and its practicability have been enhanced; the value of standing timber has been increased; and more intensive forest management has been made financially attractive.

Shifting Land Use

Between 1935 and 1954, woodland acreage declined in all sections of the Delta. The heaviest reduction occurred in Arkansas, where the net decline totaled more than 800,000 acres, a 19-percent drop. Much of the new ground in Arkansas is devoted to production of rice. These ricelands are not especially productive for timber, because their natural drainage and soil texture are poor. Their conversion to farmland, therefore, has not reduced potential forest productivity in proportion to the reduction in acreage.

The smallest amount of clearing has been done in the southern part of the Louisiana Delta, where the water table is high but forest sites are good for well-adapted species. Louisiana's South Delta forest area is now only 6 percent less than it was in 1935.

Not all land cleared since the 30's is suited to agricultural use. Some of these unsuitable areas have been abandoned and have reverted to forest. Further shifts from farm to forest are likely. But it is apparent that with the unusually favorable circumstances for agriculture in much of the Delta region, which include public participation in flood control and major drainage projects and public support of farm prices, the outlook is for further net reduction in forest acreage.

What will the forest acreage be 50 years hence? Certainly, the effects of the increasing population and its demands for food and fiber will be felt in the Delta. The forests will continue to be driven back to areas where flooding, poor drainage, and unfavorable soils preclude economic drainage. But counteracting forces are at work also. Of the 11 million acres still forested, about 2 million are in the hands of the forest industry and the public. These tracts are likely to remain forested. The industrial acreage can almost certainly be expected to increase substantially to supply the demand for hardwoods. Expansion of the pulp industry and land acquisition go hand in hand; and the changes in forest landownership should become apparent in the next decade or so.

Continued improvements in agricultural efficiency should also serve to hold land clearing in check. Improved techniques are more likely to be applied to lands already cleared than to

those occupied by forests. The cost of clearing and preparing new ground should serve to dampen the rate of conversion of forest to crop and pasture land. In the last decade, the net conversion rate (clearing less reversions to forest) has been about 75,000 acres annually. This rate should decline during the next 50 years. An ultimate 9 million forest acres in the Delta seem a reasonable resolution to the counteracting forces.

Most of the forest land estimated for conversion to cropland is on bottom-land sites. With the exception of fine-textured poorly drained sites of the kind preferred for rice production, these lands generally have the highest timber-growing potential of all forest lands in the South. This diversion of forest land will remove from timber production a very significant portion of the land now available for growing timber products. Since hardwood timber is already in short supply for high-grade veneer and lumber, tight cooperage, and other specialties, the reduction in timber-growing potential will accentuate this supply problem. Should this occur, the upward pressures on timber prices will be greatly intensified and consumption of wood products will be drastically reduced.

It must also be realized that, in addition to timber, forest lands contribute valuable benefits such as wildlife and forest recreation. The reduction of the forest area by 2 million acres would result in substantial losses of benefits from these important uses of forest land.

Markets for Forest Products

The chief primary markets for Delta timber are lumber, veneer, pulp, and cooperage plants in and on the periphery of the region. Here is the heaviest concentration of primary hardwood manufacture in the Nation.

Lumber production is a large-scale undertaking. The kind and size of timber, the logging conditions, technical difficulties in curing the products, and the exacting, complicated specifications for varied products and requirements of distant markets are compelling factors in the necessity for relatively large amounts of working capital, equipment, and skill. Less than 50 mills produce 90 percent of the lumber. Although there are hundreds of sawmills in the Delta, most of them are plantation mills. They operate infrequently to supply rough lumber for farm use rather than for market.

Most of the prime veneer logs go to Memphis, Tenn., but some go to producers in Mississippi, Kentucky, and Indiana. The ordinary commercial veneer and stave logs can be marketed throughout the Delta. The present and some prospective pulp mills that draw Delta timber are shown in figure 12.

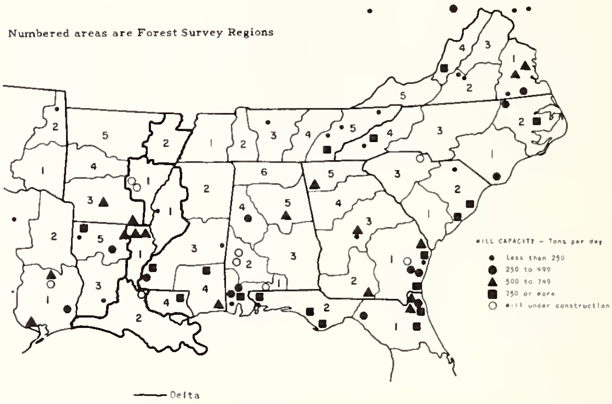


Figure 12.--Pulpmills drawing wood from the South, 1956.

About 20 years ago nearly all of the lumber, veneer, and staves were shipped rough to plants beyond the Delta for remanufacture into consumer goods. Since then, there has been a trend toward remanufacture of rough products in the Delta region. Among other things, finished flooring, hardwood doors, paneling, and furniture are now produced in the Delta. This trend is likely to continue because of the changes that have occurred in the forest resource. Only with remanufacture in or near the Delta is it possible to use much of the marginal size and quality of material that prevails.

LAND AND WATER PROBLEMS IN THE MISSISSIPPI RIVER ALLUVIAL VALLEY

Land and Water Problems[5]

Water was the primary factor in the formation of soils in the Delta and in the topographic characteristics of the alluvial plain. Water is also a major factor in soil management and its relation to productivity. Probably no other area of the United States experiences the conflict between surplus water and deficiency of water as does the Mississippi Delta. Surplus surface water in winter and spring interferes with spring preparation of land for row crops and with timeliness of tillage operations. Spring growth of young plants is often retarded because of excess water. Emergence of seedlings may be retarded because of the hard crust that forms on the surface following recession of standing water.

Removal of the surplus surface water requires surface drainage and adequate outlets. Because annual rainfall, although more than sufficient for optimum crop production, is poorly distributed throughout the year, summer

[5] For a more complete discussion of the interrelationships between soil and water problems, see Perrin H. Grissom. The Mississippi Delta Region. U.S. Dept. Agr. Yearbook (Soil) 1957. 524-531, illus.

drought is an annual hazard. Surface drainage must be provided, yet conservation of water is of prime importance. Although crop yields are affected by both excess water and too little water, the primary cause of crop failure in the Delta is lack of surface drainage and adequate drainage outlets. These water problems are the direct cause of many soil-management problems.

The relatively high temperatures and high moisture conditions of the Delta coupled with the intensive tillage of a row-crop system cause rapid decomposition of organic matter and are conducive also to loss of organic matter. Under these climatic and cultural conditions, soils quickly lose their original organic matter. Loss of organic matter results in an alteration of the soil structure, the water-infiltration rate is reduced, and runoff is increased. As depletion of organic matter continues, the physical changes that result make it more difficult to replenish and maintain organic matter. Soil erosion then becomes serious.

Although most of the land ranges from hummocky to very gently rolling, erosion is serious throughout the Delta. Loss of organic matter from surface soil has given rise to sheet erosion. As the surface soil is removed, older alluvia having less desirable physical properties are exposed. Usually in slack water areas, these subsoils are heavy clays upon which a topsoil has formed. Cultivation of these heavy clays when too wet contributes to the breakdown of the poorly developed soil structure.

The physical condition of soils in the alluvial valley frequently limits crop production. The poor physical condition of the heavy clay soils in the Delta has long been recognized. The poor condition of some of the lighter soils, however, was discovered only recently. Loss of organic matter, erosion, and improper tillage practices have all contributed to the present physical condition of the soils.

Plowpans have developed on many of the fine sandy loam and silt loam soils. In general, these developments were the result of erosion and poor management practices. Soils that have developed plowpans have a compacted zone of high-clay-content material that is impervious to water and impenetrable by most crop-plant roots. These soils are waterlogged during excess moisture and are droughty during moisture deficiency. The soils that have developed plowpans are ideally suited to rice culture for which they are widely used throughout the Delta portion of Arkansas, as well as in parts of the Delta in Mississippi and Louisiana. In those areas where soils which have developed compacted plowpans are used for crops other than rice, they present serious soil-management problems. Deep tillage or subsoiling is commonly practiced to break up the compacted layer and thus improve water infiltration and root penetration. The deep-tillage operation is successful, however, only if done when the soil is sufficiently dry to shatter the compacted layer.

Improved cropping systems and mechanization have provided opportunity to improve Delta soils. Improved rotation systems, which include deep-rooted legumes, have tended to increase organic matter. Planting of winter legumes and June plowing under when they are reaching maturity has reduced erosion and improved the physical condition of the soil. Mechanization has made possible more timely field operations. Machines reduce the time required for field operations so that farmers can delay operations until soil moisture is more favorable, thus avoiding the breaking down of soil structure. Large machines also make possible large fields conducive to more efficient layouts of farm drainage and supplemental irrigation systems.

Any soil-management program has crop production as its ultimate objective. If optimum production is to be attained, specific crops must be grown on the soils to which they are best adapted; soil treatment and soil management will partially overcome the adaptability limitations.

If information were available as to the extent that treatment and management of the soil could be used to overcome natural limitations, economics would largely determine the specific crops to be grown on given soils. Because of lack of knowledge, however, in practice, crops tend to be grown on soils to which they are best adapted.

Trends in Development of Land and Water Resources

Agricultural development, and more particularly, land development, in the lower Mississippi alluvial valley depends upon three essential activities--flood control, drainage, and land clearing. These three essential activities should move forward uniformly and in harmony. Historically they have not been carried forward uniformly, and economic losses to individuals and retardation of agricultural development have resulted.

Flood Control

Water-control problems throughout the lower Mississippi Valley, particularly flood protection and land drainage, are as old as the history of the settlement of the valley lowlands. The earliest settlers were faced with water problems, and the need for flood protection was obvious.

The Mississippi River Commission, formed in 1879, was designated as an agency of the Federal Government responsible for coordinating river-improvement work. With the formation of the Commission, stimulus was given to the formation of local levee districts, authorized to match funds and in other ways to

cooperate in developing a river-improvement program.

Although from 1822 to 1917, the Federal Government assisted local levee districts in closing crevasses and in building some of the larger levees, it did not assume responsibility for flood control. With passage of the Flood Control Act of 1928, following the flood of 1927, however, the Federal Government assumed responsibility for the repair and rebuilding of principal levees in the lower Mississippi alluvial valley. The Flood Control Act, approved on May 15, 1928, stated that in view of the great expenditure heretofore made by local interests in the alluvial valley of the Mississippi for protection against the floods of that river; in view of the extent of the national concern in control of these floods; in the interests of movement of the United States mails; and in view of the gigantic scale of the project involving floodwaters of a volume and flowing from a drainage area largely outside the States most affected and exceeding those of any other river in the United States, no local contribution to the construction cost of the project would be required. Requirements of local cooperation stipulated in section 3 of the Act of May 15, 1928, covered (a) the maintenance of completed flood-control works; (b) acceptance of ownership of lands acquired by the United States and turned over to local interests under the provisions of section 4 of the Act; (c) provision without cost to the United States of all rights-of-way for main-stem levees; and (d) holding the United States free from damages by floods. Amendments to the 1928 Act have provided for varied modifications and additions to these requirements to meet special conditions applicable to certain features of the project.[6] As the 1928 Act was carried out, local interests found it desirable to augment the program by constructing private works at many points.

Up to June 30, 1957, 2,834.3 miles of levees had been completed on the main stem of the Mississippi River and its tributaries between Head of Passes, La., and Cape Girardeau, Mo. Of the total amount of levee construction, 2,312.8 miles, or about 82 percent, had been built to approved grade and section. When completed, the adopted project would protect 23,621 square miles of flood plain, based on the project flood of record.[7]

From the viewpoint of land development and settlement of the lower Mississippi alluvial valley, the tendency of the Mississippi River and tributary streams to overflow their banks periodically has presented a problem of supreme importance. Mississippi River floods occur at the average rate of one flood each 2.8 years. Most of these floods are serious, that is, unless controlled they can result in severe damage. The frequency and severity of overflow depends upon the intensity and distribution of rain and snowfall over the far-flung watershed of the Mississippi River. Weather observations in the valley have shown that the Ohio River is the great source of floods in the lower Mississippi. The heavy spring rains on the steep slopes of the Allegheny Mountains frequently bring floods to the Ohio River just when the normal seasonal rise of the lower Mississippi brings the river bankfull from Cairo to the Gulf of Mexico. In all great floods, heavy rainfall over the bottom land that borders the Mississippi from the mouth of the Ohio to the gulf is an important factor. Although it never discharges a volume sufficient in itself to produce a flood in the lower valley, the upper Mississippi, which rises somewhat later than the Ohio, often prolongs the high water in the lower river.

Conceivably, a flood in the lower Mississippi might be caused by heavy rains over any of the great basins, but the western tributaries of the Mississippi are rarely major factors in producing great floods in the lower Mississippi. But when flooding of the western tributaries comes when the lower Mississippi River is at the danger stage, serious overflow can result. With the present levee system, floods of sufficient volume to cause general alarm arise only when severe floods occur in several of the great tributary streams in such a way that the several floodwaves are synchronized in their passage down the lower Mississippi. The disastrous flood of 1927 was caused by unparalleled precipitation in the middle drainage basin, together with a remarkable degree of synchronization of the crests of tributary streams.

Some idea of the volume of water involved in a major flood in the lower Mississippi can be obtained by a study of the differences between high- and low-water gage readings and by estimates of discharge. At St. Louis, the extreme low water recorded between 1872 and 1930 was minus 3.10 feet; the extreme high-water reading was 38.0 feet. At Memphis, for the same period, extreme low water was minus 2.65 feet and extreme high water, 46.5 feet. At the Arkansas City gage, the difference between extreme low and extreme high water was 64 feet. Farther south the difference declined; although at Carrollton, a difference of 22.87 feet between high and low water was recorded as the extreme between 1872 and 1930. In 1927, the estimated confined discharge at Vicksburg, Miss., was 2,278,000 cubic feet per second. Present project floods are designed for 2,761,000 cubic feet per second at Vicksburg. As only about 1,000,000 cubic feet per second of water can be accommodated in the channel of the lower Mississippi, in the absence of levees, major floods would send about 1,200,000 cubic feet of water per second into the interior basins. From these basins it would spread over the alluvial valley until it

[6] Chief of Engineers, U.S. Army Civil Works Activities. Annual Report for the Fiscal Year Ended June 30, Corps Engin., Dept. of Army, 85th Cong., 2d. Sess., House Doc. 254, Vol. 2, 1957.

[7] Ibid.

could find its way back into the river as the flood receded.

The volume of floodwater the channel cannot accommodate must be controlled by levees. Such a quantity of floodwater could not be confined within the leveed channel without a great increase in hydraulic efficiency of the leveed floodway over the natural flow through the much larger basins. It is conservatively estimated that floodwaters move the gulf through the leveed floodway six to eight times faster than they would move if allowed to pass through the valley in a thin sheet. For this reason, confining the Mississippi to a leveed floodway has not raised flood heights above the level that can be controlled economically by levees.

Although the alluvial valley of the lower Mississippi River now has the greatest degree of protection from floods in its history, the flood-control program is far from complete. For example, protection from Mississippi River backwater is not provided in several important basins. In the Red River Basin, for example, about 1,600 square miles are inundated by Mississippi River backwater during floods. In the Yazoo River Basin, Mississippi backwater inundates about 1,200 square miles during floods.

Land clearing

Land clearing, one of the three essential activities involved, is probably one of the least understood phases of land development. In the alluvial valley of the Mississippi, land development has been more prolonged than in other great areas of the Nation. Land clearing in the valley has been in continuous process since the 18th century. Land development has been prolonged because it has had to wait on flood control and drainage development. When flood control and drainage improvements were made land clearing followed rapidly. Unlike early clearings made in the Delta, the land clearing in progress during the last few years is done by established farmers rather than by new-land settlers.

Land clearing is so related to flood control and drainage that it is difficult to discuss the one without the others. Clearing and development of land have been greatly influenced by the fact that the higher elevations and the better drained soils are on natural levees next to the main streams. These natural levees resulted from a rapid deposition of stream loads when streams overtopped their banks. Thus, successive overflows built the banks higher and higher. This produced a sandy, easily tilled soil that sloped away from the stream. The first settlement and land clearing occurred on these natural levees, which were the last lands to flood. Also they were fertile and easily tilled, and they had natural drainage away from the stream. This largely explains the frequent ribbon-like agricultural development along streams.

The period 1905-15 marked an era of legislative activity in the Delta States, with enabling legislation passed for establishment of drainage districts. By 1920, many drainage districts had been established throughout the Delta States, and construction of drainage ditches spread rapidly. Agricultural interests responded immediately, and from 1925 to 1930, in Arkansas, Louisiana, Mississippi, and Missouri, well over 2 million acres of woodland were cleared and put into cultivation. Clearing averaged 410,000 acres each year. From 1910 to 1925, new land was cleared at an average rate of only about 24,000 acres per year. After the upsurge of clearing between 1925 and 1930, clearing operations slowed down a bit. Between 1930 and 1935, about 790,000 acres were cleared in the four States.

Available information indicates that successive 5-year-period clearings were about as follows: 1935-40, 660,000 acres; 1940-45, 720,000 acres; and 1945-50, 470,000 acres. These are net increases for open land in farms; they take into account the clearing of new land, as well as reversions of open land to woodland. The data are influenced, however, by land going from farm to nonfarm uses. Clearing has been rapid in recent years in the rice-growing areas of Arkansas. This was caused by favorable prices received for rice and also by the relatively high yields of rice on newly cleared lands. Clearing has also progressed rapidly in recent years in northeastern Louisiana, mainly to accommodate enlarged beef-cattle herds. The extended drought in Texas from 1952 to 1956 caused many Texas ranchers to buy large tracts of Delta woodland to be cleared for permanent pasture.

The rapid expansion of rice production in the rice-growing area of Arkansas ". . . required one of the most extensive private programs of land clearing in recent years in the United States. Detailed surveys of the newly cleared areas have not been made, but on the basis of recent field reconnaissance it appears that at least 100 thousand acres were cleared between the close of World War II and 1948 and that at least 100 thousand acres were cleared in the years 1948-50."[8]

The figures showing the averages of land cleared in specific 5-year periods are totals for the four States. In Missouri and Mississippi, open land in farms showed a decrease from 1950 to 1955 for the first time since 1910. In Arkansas and Louisiana, increases in open land in farms were registered for the 1950-55 period despite the fact that urbanization and industrialization were taking large blocks of Delta land each year.

In general, the period 1950-55 saw a tremendous amount of land clearing throughout the Delta. Precipitation was less than normal. Lowland areas were drier than usual, which

[8] Harrison, R. W. Clearing Land in the Mississippi Alluvial Valley. Ark. Hist. Quart., Vol. 13: 352-371 (4). 1954.

made clearing operations possible in wet and swampy areas. Concordia Parish in northeastern Louisiana, which is well away from industrial development, showed an increase in open land in farms of some 32,000 acres from 1950 to 1955. This is an increase of 45 percent during the 5 years.

After World War II, techniques of land clearing developed rapidly. Modern machines and equipment made it possible to clear large tracts of heavily forested cover quickly and economically. The uses to which newly cleared lands are put changed also. During the 1930's, considerable clearing was done by hand for the purpose of developing small farm units. The methods used were slow and costly. The cost of land clearing plus the fact that in many instances drainage facilities were not available for adequate drainage of the newly cleared lands meant that operators of these small farm units were unable to produce enough to cover their costs. Failure of the small farms was the inevitable result. Now woodlands are cleared primarily to add cropland to present farm units.

Costs of clearing land in the Mississippi alluvial valley are affected by density of timber stand, drainage, season of year, and soils. Of these, density of forest cover is the chief factor affecting clearing operations. When clearing is confined to the drier seasons of the year, most of the other difficulties can be avoided.

Throughout the Delta, the forest cover can be divided into two distinct types, depending chiefly upon drainage and wetness of sites. On the higher elevations, post oak, water oak, Southern red oak, and scaly bark hickory predominate. In the sloughs and at lower elevations, willow oak, Nuttall oak, overcup oak, sweet gum, and ash predominate. These differences in forest cover are more the direct expression of natural drainage than of soils.

At the lower elevation, forest growth is dense and trees are closely spaced. On the higher elevations, which have better natural drainage, the trees are more widely spaced and undergrowth is sparse because of fire, grazing, and wood cutting except on the poorest soils. A study of land use maps and aerial photographs and observation in the Delta disclose that in the past the upland stands of timber were cleared, leaving many elongated wooded areas most of which mark watercourses and sloughs.

The condition of the timber stand is the most important factor affecting the cost of clearing. It is also the chief consideration in deciding whether the land should be continued in forest cover for forest uses or converted to agricultural uses. Farmers and businessmen find it difficult to make wise decisions regarding future land use. Where stands of timber exist, the assistance of experienced foresters should be obtained to determine growth rates and economic returns that could reasonably be expected from the forest cover.

Farmers who clear land commonly bulldoze the felled timber into windrows which are later burned. In many areas where good stands of desirable species are being cleared, this is a waste of both resources and money. Considerable merchantable sawtimber is burned each year in the clearing process. Farmers have failed to realize the value of the resource destroyed by burning. In many instances, the value of the timber cleared from the land would pay for most if not all of the cost of clearing.

Robert W. Harrison gives the following account of land clearing in the Mississippi Valley during the last few years:[9]

> From 1955 through 1959 the rate of land clearing decreased, partly due to the wet seasons and partly to the difficulty of the clearing task on areas remaining in forests. In many areas clearing had caught up with the drainage program, and in some cases had exceeded it as was discovered in the wet seasons of 1956 and 1957. It is estimated that 623,000 acres were cleared in the Alluvial Valley from 1955 to 1959. A considerable part of the clearing from 1955 to 1959 can be traced to the benefits of the U.S. drainage program. The clearing from 1955 to 1959 was directed more to improving established farms and fields rather than to the development of new units. This has led some observers to believe that the volume of clearing was greatly reduced after 1955. . . . The lack of spectacularly large clearings as those of the 1950-55 periods accounts for the impression that clearing activities have substantially decreased in the Alluvial Valley.

Drainage

Many of the drainage problems of the lower Mississippi alluvial valley have their roots in the historical development of drainage. About 1890, several States passed legislation to permit formation of drainage districts. As the enabling legislation was the first of its kind, in general, it was poorly drawn. Relatively few drainage districts were organized before 1900. From 1905 to 1915, the States reworked their drainage-district laws in the light of past experiences and made them more workable. Although fewer than 100 drainage enterprises were established from 1900 to 1909, most of them during the last 5 years of the decade, hundreds were established in each of the next two decades. From 1900 to 1920, the organization of drainage districts reached its peak in Mississippi and Arkansas and proceeded rapidly in Louisiana and Missouri.

During this period, little thought was given to coordination between districts. As a result, many small districts were established without regard to their effects on existing districts or on areas not served by drainage enterprises. When a natural watercourse was used as an outlet for the drainage district (sometimes several districts used the same outlet), little attention was paid to the adequacy of the stream to accommodate the excess runoff from the drainage enterprise. As this condition moved farther southward through the Delta, and as more districts were organized with more of

[9] Harrison, R. W. Chap. VI. Land Clearing in the Mississippi Alluvial Valley. Manuscript.

them using the same streams for outlets, drainage became less effective.

With drainage development, land clearing also progressed rapidly, usually moving ahead of the drainage development. As clearing increased, runoff also increased. Outlets used for the drainage enterprises were not adequate to remove the excess surface water. This condition added to the damage caused by floods that occurred within the valley. Because of less slope in the lower part of the valley, this problem became more pronounced as the valley was traversed southward.

As drainage became more ineffective, it became apparent that the lands drained would not provide an increase in production sufficient to pay for the maintenance and the improvements in the drainage systems that were so badly needed. Drainage enterprises were in serious financial trouble at the time of the 1927 flood, which covered most of the alluvial valley. Many districts did not recover from this flood; those that did had to refinance.

The flood of 1927 marked the end of the great expansion in the drainage movement in the Delta. From 1930 to 1939, relatively few drainage districts were organized.

From 1940 to 1949, more drainage enterprises were installed in Louisiana than in any previous 10-year period. During this period, considerable drainage work was done in other parts of the Delta. Drainage work outside Louisiana, however, was more of the reconstruction type than new enterprise development. Drainage districts were obliged to rehabilitate and correct obvious mistakes in their systems. Of the new drainage enterprises established from 1940 to 1949, except for the 16 parishwide drainage systems developed in Louisiana, most were individual and group drainage systems.

Meager data are available from published drainage statistics concerning drainage developments from 1950 to 1957. Observations in the Delta, however, lead to the conclusion that from 1950 to 1954, a period of drought, attention was directed more toward irrigation than toward drainage. From 1955 through 1957, a period of excess rainfall, interest in drainage was again renewed.

With the hodgepodge of small individual drainage districts that exists in most parts of the Delta and the lack of proper maintenance in many districts and of adequate major drainage outlets, it has become apparent that the engineering, legal, and institutional aspects of the drainage program must be revised if an effective drainage program is to be realized. Louisiana and Mississippi have recognized this fact and have taken steps to improve drainage.

The onfarm drainage program of the Soil Conservation Service (SCS), through soil conservation districts, is hampered by lack of major outlets, Drainage districts are also hampered in their improvement work because of inadequate outlets. Lack of coordination between drainage districts, overlapping of lands between districts, and legal entanglements have greatly retarded improvement of the drainage program in the Delta.

In the Flood Control Act of 1944, the Congress authorized work on channels and major drainage improvements as part of the national flood-control program. Under the Act, main channels and outlet ditches that serve many drainage districts can be improved. The Corps were for the first time instructed to engage in drainage work not directly related to levee building and other flood-control projects. Another Federal program that can alleviate the drainage problem in the Delta is made possible by the Watershed Protection and Flood Prevention Act of August 4, 1954. This Act authorized USDA to cooperate with States and local agencies in planning and carrying out works of improvement for soil conservation and other purposes, including land drainage.[10]

Such Federal programs as planned by the Corps and the small watersheds programs planned by USDA are giant strides toward the solution of drainage problems. These programs, planned on a watershed basis, enable drainage work to start at the bottom of the watershed and work toward higher land, a fundamental criterion of drainage engineering. These programs will solve some engineering problems, but they will not solve those problems that result from lack of coordination between existing drainage systems. These problems will be solved only through the harmonious efforts of the various drainage districts within each watershed.

Irrigation

Average annual rainfall in the lower Mississippi alluvial valley varies from about 42 inches in southern Illinois and western Kentucky to about 64 inches in southern Louisiana. The geographic distribution of rainfall in the alluvial valley is shown on the isohyetal map (fig. 13). At first glance, this map seems to indicate that the entire valley is sufficiently well supplied with rainfall for bountiful crop production. But a study of the rainfall pattern discloses that rainfall is not properly distributed throughout the year for optimum crop production. In general, from November to March more rain falls than crops can use, while from May to September, less rain falls than is required. Historically, rainfall in the alluvial valley is a series of deficiencies and excesses.

It is a paradox that an area as well supplied with water as the lower Mississippi alluvial valley is plagued with droughts almost annually. Research studies conducted in the Delta indicate the seriousness of this hazard and the need for supplemental irrigation. H. C. M. van

[10] Wooten, H. H. and Jones, L. A. The History of Our Drainage Enterprises. U.S. Dept. Agr. Yearbook (Water). 478-491, illus. 1955.

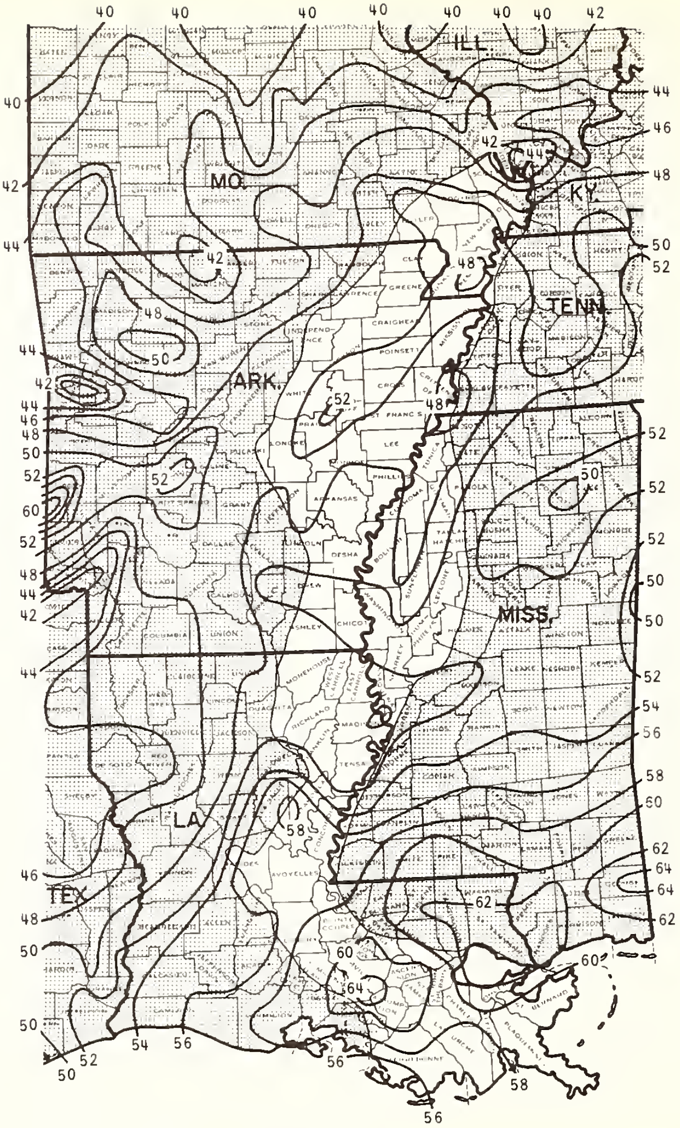


Figure 13.--Mean annual rainfall in inches, Mississippi River and Tributaries area.

Bavel, in a study of drought and water surplus in agricultural soils of the valley concludes that:

1. Appreciable soil-moisture deficiencies occur only from May through October.
2. In the alluvial valley, droughts are fewest in southeastern Louisiana and most numerous in northwestern Louisiana.
3. Drought occurrence depends markedly upon the storage capacity of the soil for water.
4. From May to October, drought is a serious and common hazard regardless of geographic area or soils. Under average conditions, many areas show a lack of available moisture half the time and very few during less than a third of the time.
5. Irrigation seems to be indispensable to maximum soil utilization in most areas of the Delta, and the required amounts of irrigation water are high. Under average conditions the amount of additional water required approaches the average rainfall in most of the area during the summer and early fall.

Van Bavel further concludes that, by and large, total annual rainfall would meet the consumptive-use requirements of farm crops in the lower Mississippi alluvial valley if the rainfall were favorably distributed. Because of the unfavorable seasonal distribution, however, the balance can be restored only by large-scale artificial changes in hydrology such

as storage of excess water in surface and underground reservoirs and the issuance of water from these reservoirs[11] during the period of demand through irrigation.

A study of drought intensity in northeastern Louisiana covering 1941 to 1954 was made by Holcombe and Wiegman.[12] The study was conducted on two soils (a silty clay loam and a loam). A drought day was considered to occur when 65 percent or more of the available moisture in the effective root zone was depleted. The findings of this study were as follows:

1. The percentage of drought days on the Mhoon silty clay loam soil ranged from 7 to 65 percent of the total number of days in the growing season, averaging 44 percent. On the Commerce loam, the percentage of drought days ranged from 17 to 75 percent of the total number of days in the growing season, averaging 48 percent.[13]
2. The number of irrigations required in the growing season ranged from 1 to 6 on the silty clay loam soil and from 2 to 8 on the loam; averaging 3.6 and 4.9 irrigations per year, respectively.
3. Rainfall deficiency during the growing season ranged from 2.77 to 16.02 inches on the silty clay loam soil and from 4.16 to 16.64 inches on the loam soil. The average deficiency for the silty clay loam was 9.97 inches, while for the loam soil it was 10.19 inches.

The need for supplemental irrigation throughout the alluvial valley has been well established, and more and more farmers are coming to realize that supplemental irrigation is necessary if good crop yields are to be consistently obtained. That this is true is indicated by the growth of irrigation in the Delta portions of Arkansas, Louisiana, and Mississippi.

From 1900 to 1949, irrigation in the lower Mississippi alluvial valley was confined almost exclusively to production of rice. Some 4 or 5 percent of the area irrigated during this period was used to produce crops other than rice. In 1949, the area irrigated in the three States listed in which irrigation was significant, as reported by the Bureau of the Census, was 444,100 acres. Of the irrigated area, 435,600 acres were devoted to rice culture, leaving 8,500 acres, or about 2 percent of the irrigated acreage to be used for other crops. From 1949 to 1954, the area irrigated in the three States increased to 993,200 acres, of which 749,000 acres, or about 75 percent, were used for rice production. The remaining 244,200 acres, or 25 percent of the area irrigated, were devoted to other crops, chiefly cotton, corn, soybeans, and pasture.

The census of 1949 listed only 5,100 acres irrigated in the Delta portion of Mississippi. A phenomenal increase in irrigation occurred in the Delta part of Mississippi from 1949 to 1954, when, according to the census, an additional 142,100 acres were irrigated. In 1954, the census reported 147,200 acres irrigated, 77,900 acres of which were rice, and 69,300 acres, or 47 percent, represented irrigation of other crops.

A similar trend in irrigation is evident in Arkansas. In 1949, only 7,300 acres of crops other than rice were irrigated. By 1954, this figure has risen to 159,300 acres. The rice acreage (all of which is irrigated) in Arkansas in 1949 was 387,900; and in 1954, it was 611,400.

In northeastern Louisiana, rice is not one of the main crops grown, but here again increasingly larger acreages of other field crops, chiefly cotton, corn, and pasture are irrigated. In the nine northeastern parishes of Louisiana lying within the Delta, 3,200 acres were irrigated in 1949; 2,800 acres were devoted to rice; and 400 acres to other crops. By 1954, the area irrigated had increased to 18,400 acres, with rice occupying 6,100 acres and other crops 12,300 acres. Although this acreage is not large compared with those of States bordering on Louisiana, it represents a thirtyfold increase in the 5 years in the acreage irrigated of field crops other than rice.

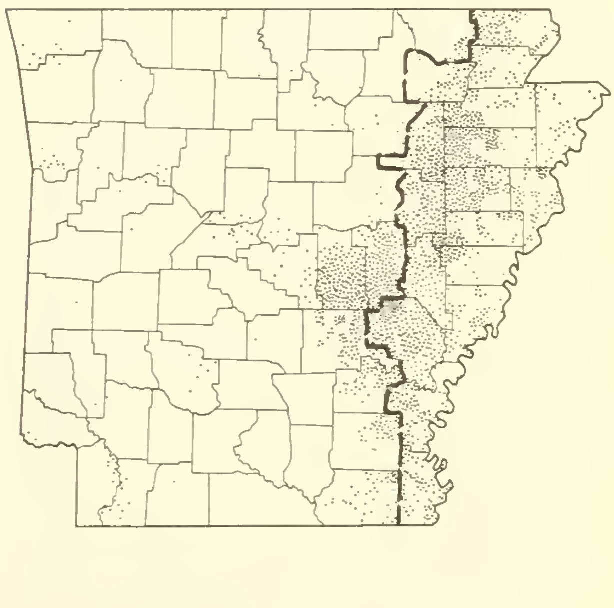


Figure 14.--Acreage irrigated, Arkansas, 1954.

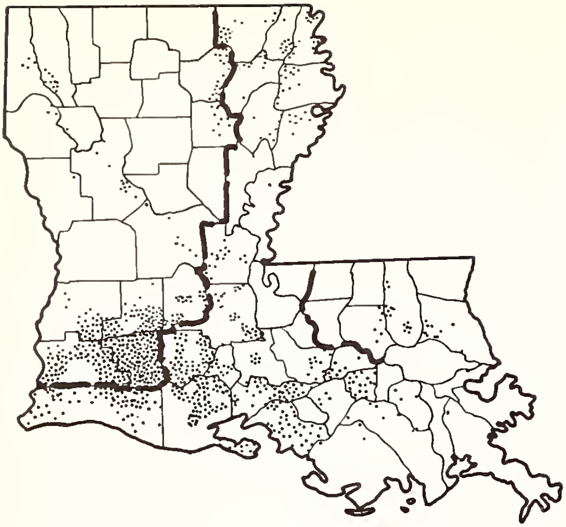
[11] van Bavel, H. C. M. Drouth and Water Surplus in Agricultural Soils of the Lower Mississippi Valley Area. U.S. Dept. Agr. Tech. Bul. 1209, illus. 1959.

[12] Holcombe, J. L., and Wiegman, F. H. Drouth Intensity and Irrigation Needs for Cotton in the St. Joseph Area. La. Agr. Expt. Sta. 1955.

[13] The study was based also on the consideration of a drought day occurring when 50 percent or more of the available soil moisture in the effective root zone was depleted.

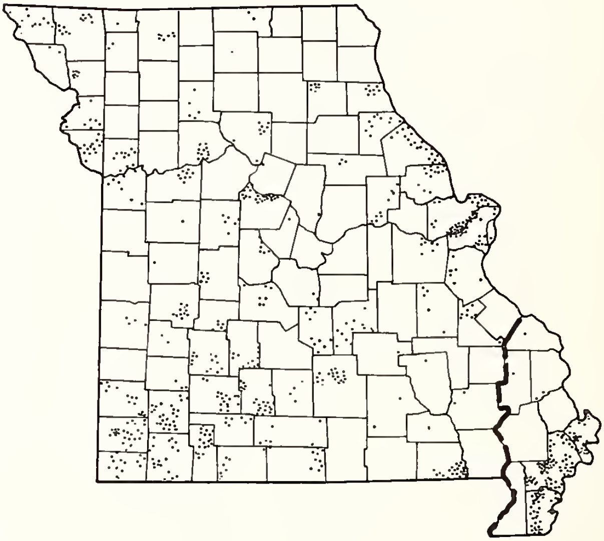
In the 15 Delta parishes of southeastern Louisiana, 57,000 acres were irrigated in 1954, with rice grown on 53,700 acres. The remaining 3,300 acres were occupied by other irrigated field crops. This small acreage of irrigated crops (other than rice, which is grown only with irrigation) in southeastern Louisiana would seem to support van Bavel's conclusion that drought in the alluvial valley is at a minimum in southeastern Louisiana.

The extent of irrigation in each of the four Delta States and in the Delta portion of each State in 1954, as reported by the Bureau of the Census, is shown in figures 14, 15, 16, and 17.



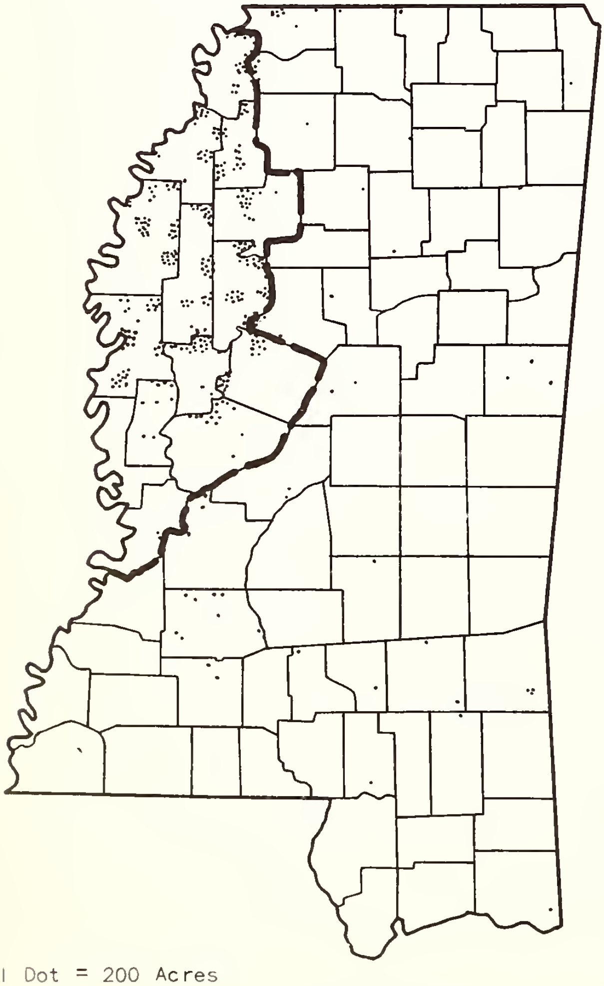
1 Dot = 200 Acres

Figure 15.--Acreage irrigated, Louisiana, 1954.



1 Dot = 20 Acres

Figure 17.--Acreage irrigated, Missouri, 1954.



1 Dot = 200 Acres

Figure 16.--Acreage irrigated, Mississippi, 1954.

PROCEDURES AND ASSUMPTIONS USED BY USDA TO EVALUATE DRAINAGE BENEFITS

Because several USDA survey parties would be collecting data and analyzing projects in each of the seven States within the project-study area, it was considered desirable that the collection of basic data and analysis of data be on a uniform basis. Uniformity in collection and analysis of data assured a degree of consistency in response to the Corps' request and also improved the efficiency of the overall survey. Guidelines and procedures were developed by USDA to assure the degree of uniformity desired.

The survey was thus divided into two phases: The basic-data phase and the project-study phase. The basic-data phase was concerned with collection of data by project areas. Data were collected on soils, land use, cropping patterns, crop yields, commodity prices, costs of agricultural production, extent of present drainage, extent of present flooding, costs of farm and group drainage, and of land clearing. To assure consistency and uniformity of data throughout the seven-State area, all estimates required for the project-study phase were based on soil units. Standards were developed by USDA for classifying all lands affected by the proposed project into soil association groups.

Soil-Mapping Units

The Mississippi River and Tributaries Project review entailed an analysis of present agricultural conditions in the Mississippi alluvial valley and of probable response to the stimuli of project development programs. Most of the economic conditions in the valley are closely related to the basic physical conditions of soil, topography, and inhibitory elements of wetness and overflow. The needs and unit costs of flood control, drainage installations, and supplemental-irrigation facilities were considered to be closely related to these physical conditions. These physical conditions formed the basis for the analysis of proposed plans for development. Therefore it was appropriate to prepare a soil survey that would result in an inventory of the entire MR&T project area.

An inventory of available soil maps of the MR&T area was made. A special reconnaissance soil survey covering the entire MR&T area was available in Arkansas and Louisiana. In Mississippi, a soil association map of the Delta was available but was not adequate for purposes of the MR&T survey. In Missouri, Kentucky, and Tennessee no maps of the MR&T area were available.

Because of the large land area involved in the MR&T project, a reconnaissance rather than a detailed soil survey was regarded as appropriate. The soil survey was made generally on quadrangle maps having a scale of 1 to 62,500, or about 1 inch per mile; in some instances, however, quadrangle sheets of a different scale were used.

The soil-survey legend used in the study consists of 17 soil groups.[14] These are virtually soil associations at a low level of generalization. Their definitions and the delineations are sufficiently detailed to give areas that are predominantly of soils that do not differ greatly in their characteristics significance in determining use suitability and management requirements. Each of these soil groups has a descriptive title that states the important characteristics and qualities that are common to most of its acreage, along with a list of the predominant series. Some soil series designated for a particular soil group occur together as a coarse complex or soil association; other soil series may be in a section of the Delta quite dissociated from areas of the others. For example, Sharkey and Alligator soils of soil group 1 are commonly associated but limited to the bottom lands of Mississippi River; whereas Portland and Miller soils of the same group, also commonly associated, are limited to the bottom lands of Red River. The generalized nature of the soil groups and their delineations on the map require that there be some inclusions of soils outside the range of the definitions. Roughly 5 to 20 percent of the acreage can be expected to consist of such soils.

Following are discussions of the 17 soil groups, in which are given (1) the names of the predominant series, followed by a descriptive title stating the important characteristics and qualities of the predominant soils, (2) a description of a soil type of the series that best characterizes the soil group, (3) a statement relating the other series listed in the title to the one for which the type is described, and (4) statements on the general nature and distribution of the soil group that aid the reader to comprehend the significance of it. The distribution of the soil-mapping units within each project area is shown in a separate atlas of generalized soil maps of the Mississippi River and Tributaries Project area.

Soil group 1.--Sharkey, Alligator, Portland, and Miller soils. Fine textured, very slowly permeable, poorly to moderately well-drained soils on bottom lands of Mississippi, Red, and Arkansas Rivers.

The Sharkey series comprises dark, poorly drained, slightly acid to alkaline alluvial soils of the Mississippi River flood plain. These soils are derived from fine textured slackwater deposits and are subject to overflow

[14] In most cases these soil groups are mapping units, although in a few cases soil groups are subdivided to mapping units in order to represent significant differences in susceptibility to flooding or in slope.

except where protected by levees. They occur in relatively large areas and are very important to agriculture.

Soil Profile: Sharkey clay

0- 4"	Very dark gray clay (gray when dry); moderate medium to fine granular structure; firm when moist, very hard when dry, slightly plastic when wet; slightly acid to alkaline.
4-18"	Dark gray clay (gray when dry); faintly mottled with yellowish brown; moderate coarse blocky structure; plastic when wet, firm when moist, very hard when dry; slightly acid to alkaline.
18-42"	Dark gray clay (gray when dry); conspicuously mottled with yellowish brown; medium coarse blocky structure; firm when moist, very hard when dry, plastic when wet, medium acid to alkaline.

The color of layer 1 ranges from very dark gray to dark grayish brown. The chief types are clay and silty clay; however, silt loam, silty clay loam, and very fine sandy loam are recognized as overwash phases. In places, layers 1, 2, and 3 are calcareous, and lime concretions occasionally occur in layers 2 and 3.

Slope ranges from level to slightly undulating, so surface runoff is very slow to slow. Internal drainage is slow to very slow. This soil is fertile, but it must be drained in order to produce good yields.

Alligator soils have lighter colored surface soils and are slightly more acid than the Sharkey soils. Miller soils are distinguished by their red color. They are calcareous and are much better drained. Portland soils, commonly associated with Miller soils, are slightly more acid and more poorly drained than the Miller. The upper 3 feet of the Portland is less red, and soil drainage is poorer.

Sharkey and Alligator soils are on the Mississippi River bottom lands and are commonly associated, although some areas mapped are very predominantly one or the other. Miller and Portland soils are on Red River bottom lands.

Most of this soil group is mapped as nearly level, but there is a small amount that is mapped as the slightly sloping phase, some as the very gently undulating phase, and a very small amount as the strongly undulating (more than 1 percent gradient) phase. Some acreage is mapped as overflow phase.

Much of the Miller and Portland is cleared. Although an extensive acreage of Sharkey and Alligator soils is cleared, drained, and used for crops and pasture, some of the most extensive areas of timber in the lower part of the Delta are on them. Cotton, corn, and alfalfa are common crops on Miller soils. Forage crops and some corn and cotton are on the cleared areas of Sharkey and Alligator.

Soil group 1a.--Perry soils. Fine textured, very slowly permeable, poorly drained soils from varicolored sediments on bottom lands of Mississippi River.

The Perry series consists of poorly to very poorly drained, acid, plastic clay soils developed in slack-water alluvium, at least the lower layers of which are reddish. Much of this reddish material apparently originated from Reddish Prairie soils. All of the Perry is subject to overflow. It differs from the Sharkey chiefly in having light colored plastic material to a depth of $2\frac{1}{2}$ or 3 feet and reddish material below this.

Soil Profile: Perry clay

0- 4"	Brown, heavy, sticky, plastic clay mottled with gray and yellow; moderately acid.
8-36"	Gray, heavy plastic clay mottled with brown and yellowish-brown; strongly acid.

Below this is red or light red alkaline clay that may have lime concretions below a depth of 40 to 48 inches.

The surface layer ranges in thickness from 4 to 12 inches and in color, to dark gray. Perry clay has a nearly level surface and occupies the lower parts of broad bottom lands. It is very slowly permeable, and internal drainage is very slow. Fertility is medium to low.

There is some acreage of Alligator soils in this soil group. It differs from the Perry soil chiefly in being mottled gray, acid, plastic clay throughout.

This soil group occupies broad, low-lying, level areas in the western part of the Mississippi bottoms in Louisiana north of Red River. They are subject to long periods of flooding. Much acreage is under deciduous forest. Some effort has been made to reclaim parts for crops, but yields are poor. Cleared and drained areas can be improved for pasture, but without drainage this soil group is suited chiefly to forest.

Soil group 2.--Tunica, Dundee, Buxin, and Gallion soils. Moderately fine textured, somewhat poorly to moderately well-drained soils on bottom lands and low terraces of Arkansas, Red, and Mississippi Rivers.

Tunica soils are somewhat poorly to moderately well-drained soils on bottom lands and low terraces. The upper 36 inches of the profile is silty clay loam, below which is coarser textured material. Tunica soils are better drained than the Sharkey; they are somewhat less plastic and occupy the slightly higher positions in the slack-water areas.

Soil Profile: Tunica silty clay

0- 4"	Brownish-gray silty clay loam; moderately plastic when wet; moderate, medium to fine blocky structure; slightly acid.

4-36'' Dark olive-brown clay, faintly mottled with gray and brown; very plastic when wet, very hard when dry; strong, medium coarse blocky structure; slightly acid.

36-42'' Gray and yellow sandy loam.

The texture of the upper part ranges to clay. The third layer ranges from sand to sandy clay loam. In places it is thinly stratified sand and clay. This coarser textured layer may be several feet thick, and in places it is within 20 to 30 inches of the surface.

Dundee soils are on slightly higher positions than Tunica and are a little better drained. Buxin soils consist of reddish clay over gray clay and they are moderately well drained. They are slightly acid to alkaline. The Gallion soils are well drained and more permeable. There are some areas of Lonoke and Yahola soils. These are also permeable and well drained, the Yahola being somewhat excessively drained. The Buxin, Gallion, and Yahola consist, at least in part, of reddish, calcareous sediments from tributaries from the west that have carried sediments from Reddish Prairie soils. The Tunica and Dundee are chiefly Mississippi River sediments.

Soil group 2 has a nearly level to undulating surface. Although slowly permeable, it is better in this respect than soil group 1, and it responds well to drainage. A great part of the acreage has been cleared and a great part is well suited for cultivation. It is productive of cotton, oats, alfalfa, corn, and soybeans. A small part has been mapped as slightly sloping (up to 1 percent gradient) and strongly undulating (more than 1 percent gradient) phases.

Soil group 3.--Sharkey and Crevasse soils. Fine textured, very slowly permeable, poorly drained soils and coarse textured, excessively drained sands on bottom lands of Mississippi River.

This soil group consists of (1) areas of Sharkey-Crevasse complex and (2) areas of Sharkey, overwash phase.

The Sharkey-Crevasse complex consists of alternate strips of Sharkey and Crevasse soils, the separate areas of these two soils being so small or intricately associated as to make their separation impractical on detailed maps. For a description of the Sharkey profile, see the description in soil group 1.

Soil Profile: Crevasse very fine sandy loam

0- 8'' Light yellowish-brown very fine sandy loam.

8-15'' Yellowish-brown friable loamy sand.

15-36''+ Light yellowish-brown very friable loamy sand or sand.

The surface soil ranges to loamy sand. The Crevasse soil is on undulations that are slightly higher than the associated Sharkey. It is excessively drained, very low in capacity for supplying available water, and low in fertility. The narrow strips of Sharkey soils in this complex are in the gentle depressions or troughs. They are poorly drained and respond to drainage. They are fertile and have a great capacity for supplying available moisture.

The areas of Sharkey clay, overwash phase, included in soil group 3 consist of 10 to 20 inches of yellowish-brown fine sandy loam or silt loam over Sharkey clay soil as described for soil group 1. The permeable layer of overwash makes it a better drained soil than normal Sharkey.

The surface of the Sharkey-Crevasse areas is gently to strongly undulating; the overwash phase areas are nearly level to gently undulating.

Most of this soil group is cleared and used for cotton and soybeans. The wide variation in the texture and drainage of the Sharkey-Crevasse complex causes its productivity to vary much. The areas of Sharkey, overwash phase, are quite productive. Most of this mapping unit is along St. Francis River in Missouri and Arkansas.

Soil group 4.--Dundee, Dubbs, Bosket, and Lonoke soils. Medium textured, moderately well and well-drained, medium to strongly acid soils on natural levees and low terraces of Arkansas and Mississippi Rivers.

Many of the areas of this soil group consist chiefly of Dundee and Dubbs soils with smaller amounts of Bosket intermixed. The areas are on the natural levees or terraces adjacent to old channels. They are higher than Sharkey soils and soils of the bottom lands, such as Mhoon and Commerce. Dundee soils are somewhat poorly to moderately well drained; the Dubbs is moderately well to well drained; and the Bosket is well to somewhat excessively drained. Lonoke is a well-drained permeable soil that predominates in areas of soil group 4 that consist chiefly of alluvium from Arkansas River.

Following are brief profile descriptions of these four series:

Dundee fine sandy loam

0- 8'' Light brownish-gray friable fine sandy loam; medium to strongly acid.

8-26'' Light yellowish-brown to brown fine sandy clay with faint gray mottles; moderate to strong medium to coarse blocky structure; medium to strongly acid.

26-36''+ Gray fine sandy clay loam, mottled with yellow and brown; medium to strongly acid.

Dubbs very fine sandy loam

0- 8'' Grayish-brown very fine sandy loam; medium to slightly acid.

8-20'' Yellowish-brown silty clay with moderate medium subangular blocky structure; friable; a few mottles; medium to slightly acid.

20-42''+ Light yellowish-brown fine sandy loam with some gray and yellow mottles; structureless; very friable, medium to strongly acid.

Bosket very fine sandy loam

0- 8'' Light brownish-gray very fine sandy loam, medium to slightly acid.
8-26'' Brown sandy clay loam; medium subangular blocky structure; friable; medium to slightly acid.
26-42''+ Yellowish-brown sandy loam; very friable; medium to slightly acid.

Lonoke very fine sandy loam

0-12'' Dark brown very fine sandy loam; slightly acid.
12-30'' Dark brown silt loam; friable; slightly acid.
30-40'' Brown silty clay loam; coarse blocky structure; friable; slightly acid.
40''+ Stratified reddish-brown to brown loam and clayey materials; slightly acid.

The surface of soil group 4 is nearly level to slightly sloping, and a considerable acreage is mapped as the gently sloping phase. A small part is mapped as strongly undulating. All of the soils are fertile and under adequate drainage have good tilth. Soil group 4 is extensive and widely distributed over the Delta. A great part is cleared and is productive of cotton, corn, and soybeans. Much of the acreage is well suited to a wide range of crops.

Soil group 5.--Commerce, Robinsonville, and Yahola soils. Medium textured, moderately well and well drained, predominantly slightly acid to slightly alkaline soils on bottom lands of Arkansas, Red, and Mississippi Rivers.

This group is similar to group 4 in drainage, texture, permeability, and general suitability to crops and management requirements. It occupies first bottom areas adjacent to present channels rather than the older, somewhat higher positions occupied by soil group 4. The profiles of group 5 soils are not as well developed, and their reaction is more nearly slightly acid to slightly alkaline.

Soil Profile: Commerce very fine sandy loam

0- 6'' Light yellowish-brown very fine sandy loam; friable; neutral to alkaline.
6-30'' Light yellowish-brown to yellowish-brown silt loam, faintly mottled in the lower part with gray; neutral to alkaline.
30-42''+ Mottled gray and brown silty clay loam; neutral to alkaline.

The texture of the surface soil of Commerce soils ranges from sandy loam to silt loam. Clay may be at a depth of 2 feet or more.

Commerce soils are moderately well drained; Robinsonville are well drained; and Yahola are well to somewhat excessively drained. The Commerce and Robinsonville are fertile and have a high capacity for supplying available moisture. The Yahola soils, having more sand throughout the profile, are somewhat less favorable in these two respects. Slope for this group ranges from level to strongly undulating.

A great part of the acreage of this group is cleared and, like group 4, includes some of the most desirable land for the production of crops. Much of the acreage is well suited to corn, cotton, alfalfa, soybeans, and truck crops. The areas of group 5 are widely distributed throughout the bottom lands. Commerce and Robinsonville predominate on Mississippi River bottom lands, and Yahola on those of Red River.

Soil group 6.--Forestdale, Sharkey, Perry, and Portland soils, overwash phases. Medium and moderately fine textured overwash on poorly to moderately well-drained clay soils of the bottom lands and natural levees of the Mississippi River.

The soils of this group consist essentially of a friable silt loam surface layer up to 12 inches thick over gray or strongly mottled plastic clay. The clay material is poorly drained, but due to the more friable material deposited on this clay, drainage conditions are somewhat better than the clay layer indicates.

The following profile of Forestdale silt loam approximates the soil character for the group:

0- 6'' Light brownish-gray friable silt loam; medium to strongly acid.
6-24'' Brownish-gray silty clay mottled with gray and brown; moderate, medium coarse blocky structure; very plastic when wet, hard when dry; medium to strongly acid.
24-36'' + Yellowish-gray silty clay loam; mottled with yellow and brown; medium to strongly acid.

The surface layer of the Forestdale soil ranges from fine sandy loam to silty clay loam; the second layer is clay in places and the third layer ranges to sandy clay loam. The layers below the surface soil of the Alligator, Sharkey, Perry, and Portland soils are clay. Most of soil group 6 has a level or nearly level surface. A significant part, however, is mapped as the slightly sloping phase. All of the soils are fertile. Acidity below the overwash layer ranges from strongly acid to slightly alkaline.

This soil group is widely distributed throughout the project area. Areas on Mississippi River alluvium are chiefly Forestdale, Sharkey, and Alligator, overwash phases, whereas those on Red and Arkansas Rivers alluvium are chiefly Perry and Portland, overwash phases. These last two have reddish calcareous clay within 36 to 50 inches of the surface.

Much of this soil group is cleared and is productive of cotton, corn, soybeans, oats, and

sorghum. All areas, however, require artificial drainage for high yields.

Soil group 7.--Collins, Falaya, Hymon, and Ina soils. Medium textured, somewhat poorly and moderately well-drained soils on bottom lands of tributary streams.

These soils consist chiefly of loessial material deposited as alluvium by streams flowing from loessial uplands occupied chiefly by Memphis, Loring, Grenada, and associated soils. The areas are along these tributaries, and where their alluvium extends out on the Mississippi River bottom land.

The following profile of Collins silt loam is representative of the moderately well-drained parts:

0- 6"	Light brown or grayish-brown silt loam containing some concretions; medium acid.
6-18"	Yellowish-brown friable silt loam containing some concretions; medium acid.
18-40"+	Mottled gray, yellow, and brown silt loam containing some concretions and, in the lower part, dark brown stains; medium acid.

The Falaya and Ina soils are somewhat poorly drained. They lack the yellowish-brown second layer of the Collins. In its place is pale yellow mottled with gray silt loam. The Hymon and Ina soils contain an appreciable amount of sand, the predominant texture being fine sandy loam or loam. Hymon, like Collins, is moderately well drained.

Areas of soil group 7 are nearly level and subject to overflow by the tributary streams. Those areas on the Mississippi River bottom lands, where not protected, are also subject to flooding by Mississippi River backwater. The soils are moderately fertile and medium acid. They are permeable, have good tilth, and have a moderately high capacity for available water. Much of the better-drained parts (Collins and Hymon soils) are cleared and used for crops, chief of which are corn, soybeans, sorghum, cotton, and pasture. Although some of the somewhat poorly drained soils are cleared and used for soybeans, corn, and pasture, much is under cutover deciduous forest. The somewhat poorly drained soils are the more extensive, a little lower lying, and more subject to overflow than the moderately well-drained soils. A very great part of this soil group is capable of responding to adequate water control and good management.

Soil group 8.--Waverly, Falaya, Beechy, and Ina soils. Medium and moderately fine textured, poorly and somewhat poorly drained soils of the bottom lands of tributary streams.

These soils, like those of soil group 7, consist chiefly of loessial material deposited as alluvium by streams flowing from loessial uplands. The areas are along these tributaries and where their alluvium extends out on the Mississippi River bottom land.

The following profile of Waverly silt loam is representative of the poorly drained parts:

0- 2"	Gray silt loam.
2-12"	Very light gray silt loam mottled with brown that breaks easily to a friable, floury mass.
12-30"	Gray, stiff, tough silty clay or clay mottled with pale yellow and brown.
30"+	Gray, mottled with yellow and brown silt and clay.

Beechy, like Waverly is poorly drained; it contains more sand than does the Waverly, the texture ranging from fine sandy loam to silt loam. Falaya and Ina soils are somewhat better drained. Their upper subsoils are pale yellow mottled with gray.

Areas of soil group 8 are nearly level and subject to frequent overflow by the tributary streams. Those areas on the Mississippi River bottom lands, where not protected, are also subject to flooding by Mississippi River backwater. The soils are moderate to low in fertility and medium to strongly acid. The poorly drained soils (Waverly and Beechy) have slow permeability due to the clayey subsoil. All of the soils have at least a moderate capacity to supply available water to plants when adequately drained.

A small part of the Falaya and Ina soils is cleared and used for corn, soybeans, and pasture. Much of the remainder is still under cutover deciduous forest wetness and great hazard of overflow. Drainage and control of overflow is necessary if areas of this soil group are to be cultivated or productive of improved pasture.

Soil group 9.--Richland, Freeland, Lintonia, and Dexter soils. Medium textured, moderately well and well-drained soils of loess terraces.

This group is on stream terraces consisting chiefly of loessial alluvium that originated in the upland areas consisting of Memphis, Loring, Grenada, and associated soils. It is chiefly on the "Loessial Terraces" in Arkansas and Louisiana[15] and the western part of the Delta in Missouri. Areas are smaller and the aggregate area is less than for group 10.

Richland, a moderately well-drained soil with a pan at a depth of about 24 inches, predominates.

Soil Profile: Richland silt loam

0-10"	Light grayish-brown silt loam.
10-24"	Brownish-yellow to yellowish-brown silt loam or silty clay loam; weak to moderate subangular blocky structure; friable.
24-28"	Yellow silty clay loam, mottled with gray and brown; friable but slightly compact.

[15] "Loessial Terraces," as shown on the "Soil Association Map of Arkansas," dated April 1959, and "Generalized Soil Area Map, Louisiana," dated May 22, 1958.

28-40"	(Pan) Brown silt loam or silty clay loam, mottled with yellow, gray, and brown. Firm in place, but breaks with brittleness to a friable floury mass. The compact, brittle character diminishes below 40 to 48 inches. The pan varies in thickness from 12 to 36 inches.

Freeland soils, like the Richland, are moderately well drained and have a pan. A noticeable amount of sand is intermixed with the silty material. Lintonia and Dexter are well-drained soils, the Lintonia being quite free of sand, the Dexter having a noticeable amount of sand intermixed with the silty material. Both the Lintonia and Dexter are free of mottles to a depth of 30 inches or more and have no pan.

Areas of soil group 9 are nearly level to sloping. They are not commonly subject to overflow. The most nearly level parts of the Richland and Freeland may be somewhat improved for crops by drainage. All of these soils have good tilth and a moderately high capacity for supplying water to plants. They are moderately fertile and respond well to good management. A great part of the acreage is cleared and cultivated and is well suited to a wide variety of crops, including cotton, corn, small grains, soybeans, hay crops, and pasture.

Soil group 10.--Olivier, Crowley, Calhoun, and Carroll soils. Medium textured, poorly and somewhat poorly drained fragipan and claypan soils of loess terraces.

Much of this group is on broad, nearly level, low-lying stream terraces. The poorly drained soils, Crowley, Calhoun, and Carroll, predominate in some places, and the somewhat poorly drained soil, Olivier, predominates in others. This is an extensive group. It is chiefly on the "Loessial Terraces"[16] in Arkansas and Louisiana and the western part of the Delta in Missouri. These areas are mostly west of Crowley's Ridge and St. Francis River in Arkansas and Bayou Macon in Louisiana. Although most of the area is nearly level, some is mapped as the slightly sloping and very gently undulating phases.

Soil Profile: Calhoun silt loam

0-14"	Light brownish-gray friable silt loam.
14-18"	Light gray or light brownish-gray heavy silt loam with a few yellowish mottles.
18-25"	(Pan) Light brownish-gray silty clay loam mottled with light gray; moderate medium platy structure.
25-36"+	Light brownish gray silty clay mottled with light gray; moderate medium angular blocky structure.

Small rounded dark brown concretions are common throughout the soil. Depth to the pan varies from 10 to about 30 inches.

[16] See footnote 15.

Carroll soils have light gray surface soils and a claypan at a depth of about 12 inches. They are not extensive. Crowley soils have a claypan at a depth of about 16 inches and are darker (dark grayish-brown) down to the claypan. They are fairly extensive in Louisiana and Arkansas.

Olivier soils are somewhat poorly drained. Much of the acreage has a well developed fragipan; in places, the pan is not so striking.

Soil Profile: Olivier silt loam

0- 4"	Dark yellowish-brown silt loam, friable.
4-16"	Yellowish-brown silt loam; blocky structure; friable.
16-20"	Light yellowish-brown silt loam; mottled; blocky structure; friable to firm.
20-48"	(Pan) Light gray silt loam; distinctly mottled; compact in place; breaks with brittleness to floury mass.
48"+	Mottled yellowish-brown and gray structureless silt loam.

The entire profile is strongly acid. Manganese concretions are common throughout the soil.

These soils in their natural condition are wet much of the time except during the driest parts of the late summer. At that time these soils may be very dry. They are low in fertility; and the pan, especially in the Crowley, Carroll, and Calhoun, interferes with root development of the common crops.

Much of this soil group is still under cutover deciduous forest except for a considerable acreage in Arkansas that is used for rice. Most of the rice is on Calhoun silt loam, and the crop is grown under careful water management. Practically all of the acreage requires artificial drainage for such crops as corn, soybeans, and small grains, and for high-quality pasture.

Soil group 11.--Beulah, Robinsonville, Crevasse, and Lonoke soils. Medium and moderately coarse textured, well-drained soils of the bottom lands and natural levees of the Arkansas, Red, and Mississippi Rivers.

This group is distinguished for its adequate soil drainage. Drainage is somewhat more rapid than for groups 4 and 5, the sandier part being somewhat excessively drained. Group 11 soils are also coarser textured than those of groups 4 and 5; they are not as coarse textured or droughty as those of group 12. Those areas of group 11 in Louisiana have somewhat less adequate drainage than the areas in other parts of the Delta and accordingly will respond some to drainage. The slope ranges from nearly level to gently sloping, and much acreage is mapped as slightly sloping (single slopes with gradients of more than 1 percent) and strongly undulating (complex slopes of more than 1 percent) phases.

One of the more extensive series of this group is Beulah, a well to somewhat excessively drained, moderately coarse textured series on natural levees.

Soil Profile: Beulah very fine sandy loam

0- 8"	Light brownish-gray very fine sandy loam; very friable.
8-30"	Light yellowish-brown fine sandy loam; very friable; little structure.
30-42"+	Light yellowish-brown sandy loam; very friable to loose.

The entire soil is medium to slightly acid. The soils of this series are easily worked, but they are not high in fertility and have a lower capacity for supplying water than the soils of groups 4 and 5.

Robinsonville and Lonoke soils are a little finer textured and more fertile and have a somewhat greater capacity for supplying water. Crevasse soils are coarser textured than the Beulah and are therefore more droughty and are low in fertility.

Nearly all of soil group 11 is cleared and cultivated. Corn, cotton, soybeans, oats, hay crops, and truck crops are common. Except for the most sandy parts, they respond well to management and give good yields. All of them have good tilth. The sandier parts, in addition to being droughty, are subject to blowing.

Soil group 12.--Crevasse and Pulaski soils. Coarse textured, excessively drained soils of the bottom lands and natural levees of the Arkansas, Red, and Mississippi Rivers.

This group represents sandy areas that are low in water-supplying capacity and plant nutrients and very subject to blowing. In general, they are on the higher parts of natural levees. The Crevasse soils are on the Mississippi River bottom lands, and the Pulaski are on the Arkansas and Red River bottom lands.

Soil Profile: Crevasse loamy fine sand

0- 6"	Light yellowish-brown loamy fine sand.
6-20"	Yellowish-brown loamy fine sand.
20-42"+	Light yellowish-brown loamy sand.

Texture of the surface soil ranges from very fine sandy loam to loamy sand, and the lowest layer ranges to sand. Reaction ranges from strongly acid to alkaline. Slope ranges from gently sloping to sloping.

The soil group is not extensive. Most of it is in northeastern Arkansas and the eastern part of the Delta in Missouri. Most of it is cleared and used chiefly for hay, cotton, corn, and soybeans. These soils do not need drainage. Their low capacity for supplying water to plants, their low fertility, and their susceptibility to blowing limit the yields and make careful management necessary.

Soil group 13.--Sandy alluvial land. Very sandy alluvial deposits. This soil group consists of coarse sterile sands deposited during high water. Many deposits resulted from breaks or crevasses in main-line levees, and most of them buried otherwise productive soils. Where these deposits are but a few feet thick, farmers may spread the sand so as to get the underlying soil near enough to the surface to mix it with the sandy material by deep plowing. Some of the areas are fairly productive of such crops as watermelons, even though not mixed with the underlying soil. Some areas, however, are of very little or no value for growing crops and are a decided hazard as they may move into adjacent areas of productive soils by blowing. The total area of this soil group is very small.

Soil group 14.--Swamp. Very wet and poorly drained land covered with water most of the time.

These are permanently wet wooded areas. The water table most of the time is above the surface and the areas are not considered reclaimable for crops or pasture. The total area mapped is small. More extensive areas are in some parts of the Delta, not mapped.

Soil group 15.--Loess upland. Loessial upland adjacent to the flood-plain soils.

This soil group consists of the very gently sloping to hilly upland adjacent to the alluvial plain of the Delta. It consists of soils developed in loessial material chiefly of the Memphis, Loring, and Grenada series. Soils in this group represent a wide range of drainage, slope, and degree of erosion conditions. They are the soils from which much of the silty alluvium originated in which the soils of groups 7, 8, 9, and 10 developed. This soil group includes chiefly Crowley's Ridge and the upland in Mississippi, Tennessee, and Kentucky directly east of the Delta. Areas represented by soil group 15 are not expected to be benefited by the Mississippi River and Tributaries Project.

Soil group 16.--Forestdale and Sharkey soils, coarse textured overwash phases. Slowly permeable, poorly drained soils with coarse to moderately coarse surface layers on bottom lands of the Mississippi River.

This soil group has a coarser textured surface soil than soil group 6. The overwash layer, where it is on buried Forestdale or Sharkey[17] soil, ranges from loamy sand to sandy loam; where it is on a buried soil having a thinner clay layer with moderately coarse material below (Bowdre series), it ranges from loamy sand to clay.

Profile description taken in an area of soil group 16 (Bowdre):

0- 8"	Very dark brown very friable sandy loam; weak coarse granular structure; strongly acid.
8-14"	Dark gray very firm clay with many medium to large mottlings of dark reddish-brown; massive; plastic; medium acid.
14-22"	Gray, nearly loose loamy sand with mottling of dusty red; weak coarse angular blocky structure; medium acid.

[17] For a description of Forestdale, see profile description for soil group 6; for a description of Sharkey, see profile description for soil group 1.

22-29"+ Gray, very friable sandy loam, mottled with red and yellowish-brown; fine weak angular blocky structure; medium acid.

The surface of this soil group ranges from level to hummocky. The capacity for supplying water to plants is great, and fertility is medium to high. Most of this soil group is medium acid. All of it requires drainage for crops and good quality pasture. It responds well to good management. Nearly all is in cultivation, and under good management high yields of cotton, corn, soybeans, and alfalfa are obtained.

This soil group is small, and all of it is in northeastern Arkansas and southeastern Missouri.

Limits of Project Study--Project Boundaries

The area to be covered by the evaluation study of each subproject area was delineated by the Corps. The Corps divided each subproject area into zones to facilitate engineering and economic analyses. These zones--A, B, and C--defined the area of project effectiveness and the kinds of benefits to be realized from project development.

The A zone in each subproject was defined as the zone that was relatively free from any flood hazard. Benefits in the A zone were considered to be those attributable to drainage only. All lands in this zone lie above the high water contour of the flood of record.

The B zone was considered to be that area lying between the maximum flood contour and the 3-year flood-frequency contour. Lands in this zone were expected to benefit from both flood control and drainage.

Lands in the C zone were defined as those lying below the 3-year flood-frequency contour. They were considered as those lands not to benefit from drainage.

In addition to delineating zones, the Corps divided each subproject into stream reaches. Each stream reach, which was delineated by hydrologic study, was evaluated independently to provide data that would enable the Corps to better determine the scale of project development in the analysis of each subproject.

Subproject boundaries, zones, and reaches were delineated on quadrangle sheets and furnished by the Corps to USDA for use in making the drainage-benefits evaluation.

Major Land Use

Information as to the extent of open land, woodland, and watered and urban areas in each subproject was provided by the Corps. In many instances, because woodland conversions had caused changes since the aerial photographs from which the Corps took the data were made, it was necessary to make field checks and, where necessary, to revise the open and wooded acreages. These revisions were made in the field by USDA.

Present Cropping Patterns

Although not used directly in the project analysis, information as to current cropping patterns was obtained to serve as a point of reference in estimating future cropping patterns. Two methods of sampling--random sampling and the line-transect method--were used to obtain cropping data. The latter consisted of driving through a project area on roads at right angles to the drainage. The roads were driven at suitable intervals--every 2, 3, or 6 miles, depending upon the length of the drainage area and the availability of roads in the area. Stops were made about every 0.2 mile, and information concerning crops grown was recorded on the quadrangle sheet for the appropriate soil unit.

When random sampling was used, the cropping pattern within each tract in the random sample was recorded on the quadrangle sheet for each appropriate soil unit within the sample.

Future Cropping Patterns

Estimates of future cropping patterns for both with and without project conditions were based on the composite judgment of technicians who were familiar with each subproject area. In making the estimates, consideration was given to trends in land use and cropping patterns within the area or within areas similar with respect to soils.

Estimates of future cropping patterns were based on these assumptions: (1) No acreage or production controls in effect in the future; (2) reasonable technological advances in land-management practices; (3) highly mechanized farming; and (4) the percentage of cropland used for production of such higher value crops as cotton, rice, soybeans, and corn increased as the amount of land drained increased.

Estimates of Future Land Clearing

Estimates made by USDA of the amount of land clearing that would be done in the future without the project were based on the type of present development in each subproject area. For some subproject areas where agriculture was already well developed and land clearing had progressed rapidly during the last few years, it was estimated that most of the woodland in farms would be cleared on all soils well adapted to agricultural production. Large woodland tracts, even though included in farms, were not considered to be available for agricultural production if they were considered to be dedicated to woodland production in the future, regardless of soil type and quality. In areas where soils were considered suitable for agricultural production, considerable land clear-

ing was anticipated even though the areas might be poorly developed at present. In other areas that are poorly developed, little land clearing was expected if the soils were better suited to timber rather than agricultural production.

In all instances, it was assumed that land clearing would progress directly with drainage on all suitable soils in those areas in which the land must be drained before it can be developed. One of the objectives was to estimate the land clearing that would be made feasible by the project.

Crop Yields

All estimates of crop yields were made on the basis of flood-free conditions; that is, they were considered to be those yields that would be realized during years of normal precipitation but no flooding. Flood-free yields were requested by the Corps for use in evaluating benefits from flood control in the B zone.

For some areas within the alluvial valley, estimates of present flood-free yields were available from prior surveys. These yield estimates were reviewed and revised when revision seemed desirable. In other areas, for which previous studies of crop yields had not been made, field schedules were taken to obtain yield information by soil units.

Estimates of future yields without the project were made by adding to the estimated current yields the increment expected from technological innovations. Increases in yields from such innovations were estimated by technicians of USDA in cooperation with State college personnel in the area. Estimates of future yields with the project were made by adding to the estimated yields without the project the increment expected to result from drainage. The yield increment from drainage was estimated from interviews with farmers who had installed drainage systems in the last several years. These estimates were supplemented by judgment of technicians. Yield increments from irrigation were based on interviews with farmers and consultation with State college personnel.

Costs of Farm Drainage Systems

The extent of the need for agricultural drainage for all subprojects was determined from basic tabulations of land classes. Acreages of all wet lands were tabulated by soil units, with overflow phases and significant topographic features tabulated separately. This provided the basis for developing an inventory of the extent of wet lands needing drainage and also the present extent of lands already having sufficient drainage, natural or artificial.

Estimates of the amount of land to be drained in the future without the project were made by projecting the current drainage trends. Estimates of the acreage to be drained with the project were obtained by estimating the percentage of land needing drainage that would participate in the project. The acreage estimated to be drained in the future without the project was subtracted from the acreage of wet land tabulated. To this remainder was applied the percentage of land anticipated to participate in the project. This gave an estimate of the land to be effectively drained with the project. The estimate was subsequently reduced by 10 percent to allow for land in nonproductive agricultural uses such as farmsteads, farm roads, ditches, and so on, which was assumed to remain as undrained land. The resulting net acreage was estimated to be the land that would be drained with the project.

Because farm drainage installation and maintenance costs differ by land use for certain crops (rice, for example), the cropping pattern for each soil unit was considered. All croplands (except rice and pasture lands) were tabulated together. Acreages of rice and pasture were tabulated separately for use in estimating farm drainage costs. By applying the estimated cost of earthmoving to the necessary amount of excavation required for drainage of each type of crop--general, rice, or pasture--the estimated cost of farm drainage construction was determined. The estimated construction cost was increased by 20 and 10 percent to allow for engineering costs and for contingencies, respectively. Table 15 presents the guides established for estimating farm drainage costs.

The useful life of a farm drainage system was assumed to be governed by the stability of agriculture within a subproject area. If the area concerned was presently well developed and the existing type of agriculture well adapted to the area, any new development was assumed to be fringe development of the same general character. A farm drainage system in such an area was estimated to have a useful life of as much as 20 years. In areas with few roads in which agricultural development would involve considerable conversion of woodland, however, and where the type of farming either was not well established or was established around crops that were comparatively unstable economically, the useful life of farm drainage systems was estimated to be as short as 5 years.

The annual-equivalent cost of all farm drainage installations was computed by using amortization periods based on the estimated length of useful life and a 5-percent interest rate for financing private investment.

Costs of Group-Drainage Systems

A reconnaissance of the existing group-drainage facilities was made in each subproject area. All group-drainage facilities required for proper drainage of each area were investigated. Reaches of existing drains requiring renovation and extension were mapped on quadrangle sheets.

Construction quantities and costs required for each reach of the group-drainage systems were estimated by SCS engineers. The estimates included costs of excavation, spreading spoil,

TABLE 15.--Guide for installing farm drainage systems[1]

Item	Soil--mapping units										
	1			2		3 and 6 cropland and pasture	4 and 5		7 and 8		10, rice and pasture
	Cropland	Pasture	Rice	Cropland	Pasture		Cropland	Pasture	Cropland	Pasture	
Field drains, V-ditch, 12 in. deep, 6:1 side slope:											
Footage per acre............	150	55	None	100	55	75	60	50	60	None	None
Cost per acre...............	Compute	Compute	--	Compute	Compute	Compute	Compute	Compute	Compute	--	--
Field laterals, V-ditch:											
Footage per acre............	30	30	55	30	30	30	30	None	50	50	55
Depth per foot..............	2.5	2	2	2.5	2	2.5	2.2	--	3	3	2
Side-slope..................	3:1	4:1	2:1	3:1	4:1	3:1	4:1	--	3:1	3:1	2:1
Cost per acre...............	Compute	Compute	Compute	Compute	Compute	Compute	Compute	--	Compute	Compute	Compute
Farm laterals, 4-ft. bottom width, 3-ft. depth, 1½:1 side slope:											
Footage per acre............	10	10	10	10	10	10	10	10	20	20	10
Cost per acre...............	Compute	Compute	Compute	Compute	Compute	Compute	Compute	Compute	Compute	Compute	Compute
Structures, cost per acre......	$2.50	$1.00	$2.50	$2.50	$1.00	$2.50	$2.50	$1.00	$2.50	$2.50	$2.50
Vegetation of field laterals, cost per acre................	$1.00	0	0	$1.00	0	$1.00	$1.00	0	0	0	0
Land smoothing, cost per acre[2].	--	$5.00	--	--	--	--	--	--	--	--	--
Clearing right-of-way for farm laterals, cost per acre.......	$0.25	$0.25	$0.25	$0.15	$0.25	$0.25	$0.10	$0.10	0	0	0
All construction costs per acre.........................						(Summation of costs)					
Maintenance costs as percentage of construction costs.........	25	3	5	15	3	20 cult. 10 past.	15	3	15	5	5

[1] Amounts, specifications, and costs are average costs per acre used in making estimates in the Mississippi River and Tributaries Project study.
[2] Costs may be included for soil units other than those shown, but when this is done, a 25-percent reduction in amount and cost of field drains should be used.

clearing rights-of-way, rights-of-way easements, crossings, swinging water gaps, grade-control structures, flap gates, and vegetative planting. Ten percent of the estimated construction cost was added to cover engineering costs, and an additional 10 percent was added for contingencies and legal fees.

Maintenance costs of group-drainage systems were estimated to range between 3 and 8 percent of the estimated construction cost. It was believed that maintenance costs would vary according to soils, upland erosion, and climate.

In determining the carrying capacities for grade-control structures, a minimum 25-percent increase over drainage coefficient capacity was used. In some instances, local conditions suggested a greater increase.

Estimates of costs of group-drainage facilities were converted to an annual-equivalent basis by applying an interest rate ranging from 3 to 3½ percent over the anticipated life of the drainage works. The interest rate used in a given subproject area was estimated on the basis of past experience in financing drainage enterprises. Most group-drainage facilities were amortized over a period of 20 years. The anticipated realistic life of group-drainage works varied somewhat among project areas.

Commodity Prices and Production Costs

The projected prices and costs used in the evaluation of MR&T projects were tied to an all-product index of 235 for prices received by farmers (1910-14 = 100) and an index of 265 for prices and rates paid by farmers (1910-14 = 100) including items used in production, interest, taxes, and wages. These general levels were established by USDA in 1957 for use in evaluating work plans for watershed-protection and flood-prevention projects and for river-basin development evaluations.

The price-cost projections used were considered to represent the level of prices that could be expected to prevail over an extended period of years under assumptions of relatively high employment, a trend toward peace, continued population and economic growth, and a stable general price level. Under these conditions, the general level of prices received by farmers and cost-price relationships were not expected to differ greatly from those prevailing from 1953 to 1955. The projections implied some improvement in agricultural price-cost relationships from 1955 levels, reflecting the large surpluses of some commodities and the possibilities for some easing in industrial prices, which could come from an enlarged industrial capacity and increasing competition. The projections took into account also recent changes in supply and requirement expectations of particular crops. In general, the projections reflected the long-term levels that might reasonably be expected with production and requirements in balance under competitive conditions.

Production costs for all field-crop enterprises

used in the project study were developed from farm budget studies of large and small Mississippi River bottom-land farms in the Yazoo-Mississippi Delta and from farm budget studies of large and small rice farms in the Grand Prairie Region of Arkansas. Because production costs by enterprises differ for large and small farms, the computed costs were weighed in accordance with the proportionate acreage of land in large and small farms expected in future conditions in each subproject area.

Production costs used for evaluation purposes included all operational costs required to attain yield levels used in the analysis, overhead, and management charges. Land charges were omitted from the cost analysis because net returns to land were being determined for the future with and without project conditions.

In developing the cost data, separate estimates were made of specified, overhead, and management costs.[18] Specified costs were divided into preharvest and harvest costs. Overhead costs included depreciation on buildings; building maintenance and repair; taxes; insurance; overhead labor which included strawboss, shopman, and bookkeeper (pertaining only to large cotton farms); tractor drivers and tractor and machine use not allocated to specific enterprises; transportation; interest on operating capital; and miscellaneous general farm expenses. The estimated management costs included remuneration to hired management and all hired consulting work required plus a management wage for the operator. Production costs did not include land clearing, smoothing, or leveling, or costs of irrigation and drainage systems. In those instances in which supplemental irrigation was involved on crops other than rice, an irrigated crop, irrigation costs were computed separately and added to the standard production costs. These irrigation costs consisted of preharvest and overhead costs.

As low-yielding farms commonly operate at a lower level of overhead, the overhead costs on these farms were reduced item by item to arrive at an estimated minimum overhead cost for marginal operators. Allocation of overhead costs to specific costs was based on the ratio between each crop's specified costs and the total specified costs for the farm. A minor deviation in this procedure was made for cotton. The relatively high specified cost for cotton seemed to have caused a disproportionate share of the overhead to be charged to cotton. When this situation prevailed an adjustment was made in the allocation.

Management charges were determined by farm size at the production level indicated in the farm budget analyses. Estimates of management cost were based on experience in the Delta on farms and plantations where most or all management decisions are made by hired farm managers and superintendents. It was assumed that no legitimate charge for management could be made when specified costs plus overhead costs were equal to gross returns. That is, the marginal producer was assumed to exercise about the same degree of managerial ability as the wage hand, and therefore was adequately remunerated for such management by the prevailing wage rate. At the marginal point, the return to both land and management was zero. This established the minimum charge for management, and for purposes of MR&T analyses, the point at which net returns to land were assumed to be zero after taxes. Management charges were allocated to the various crop enterprises in the same way as overhead costs.

[18] Specified costs are defined as those farm costs that pertain exclusively to a specified enterprise.

Forestry Data

Woodland yields were based on average growth rates applicable to the species and stand sizes and ages in each area sampled in the timber survey. Forest yields used represent the units of wood products and value expected to be attained for the next 50 years under the level of management that could be expected to prevail based on present findings in each subproject area. This level of management was below potential and in some cases assumed hardly more than basic fire control. Board-foot and cubic-foot units of measure were used to determine forest values per acre.

Assumptions Used

Assumptions concerning zones of project influence

All lands evaluated in the A zone, the zone of drainage benefits only, were lands to be drained with the project. In all reaches studied, it was assumed that not all lands would participate in the drainage project. Therefore, a percentage factor was applied to each reach for each soil unit to determine the net acreage of land to be drained with the project. Lands already drained, those estimated to be drained in the future without the project, and those not needing drainage because of their physical and topographic features were omitted from the acreage determination of land needing drainage. Also omitted were those lands not expected to participate in the drainage project.

All lands in the B zone that were anticipated to participate in the project were included in the evaluation study regardless of need for drainage. All lands in this zone that were expected to participate in the project were regarded as subject to flooding to some degree and were therefore included so that the Corps could evaluate flood-damage benefits on those lands. However, all lands in both the A and B zones that were expected to be drained without a project, whether already drained, not needing drainage because of physical characteristics,

or to be drained in the future even without a project, were assumed to have the same cropping systems and the same production and net returns with as without the project. By this assumption, the lands included in the evaluation study but not influenced by the project did not affect the evaluation of benefits on lands affected by the project.

As the Corps made flood-damage analysis of all open lands in the C zone, these lands were evaluated in the benefit analysis. Because no benefits from drainage occur in the C zone, however, the same cropping systems, production, costs and net returns, both with and without the project, were used.

Assumptions concerning major land use and land clearing

In estimating the amount of land that would be cleared in the future with and without the project, the present rate of clearing, soils, economics, and whether the land was available for clearing or dedicated to woodland production in the future were considered. In instances where woodlands are dedicated to future timber production, it was assumed that such lands would not be cleared regardless of soil type or quality.

The open land estimated for the future without the project was the existing open land plus the acreage estimated to be converted without project development. The acreage of open land estimated for the future with the project was the acreage estimated without the project plus the acreage of woodland to be converted with the project.

The net amount of woodland conversion estimated to participate in the project was a percentage of all land converted. That is, a certain percentage of the woodland converted to open land was estimated to participate in the drainage development for each soil unit in each reach of the area studied.

In determining the acreage of woodland to be converted in each reach, the size of woodland tracts and the ownership pattern of the woodlands were considered. Large tracts of woodland owned by a single owner were assumed not to be available for conversion, as such tracts were dedicated to forestry production. It was assumed that most of the woodland in comparatively small tracts within farm ownerships would be available for conversion provided the soils were suitable for agriculture. All lands owned and/or controlled by forestry interests were assumed to be unavailable for conversion.

Assumptions concerning future cropping patterns

Cropping patterns for the future with and without the project were assumed to be those that would result from the reasonable application of improved technology and an estimated degree of drainage development. The application of technological innovations to permit the more intensive use of land together with the know-how to manage heavy "buckshot" lands was taken into consideration for all future conditions. For those lands to be drained with the project, it was assumed that drainage would allow a more intensive use of land. Therefore, in most instances, the acreage of land that would be used for cotton, soybeans, and corn was considered to depend upon the acreage to be drained with the project. In some instances, as in northeastern Louisiana, where the cattle industry is expanding and grass has become increasingly important in the farm organization, this trend was considered in estimating future cropping patterns. It was assumed also that all croplands would be used to best advantage--for example, a larger percentage of lands that have potential for high cotton yields would be used for cotton; soils best adapted to corn would have a higher percentage of corn and so on. All future estimates of cropping patterns considered the need for sound rotation systems, and for all lands, the quantities of small grains and sod-forming crops necessary to assure a good rotation were included in the cropping pattern.

All future estimates were made on the assumption that there would be no production controls or acreage allotments. This allowed the acreages of all crops to be expanded according to crop adaptability and sound land use programs.

About 10 percent of the total acreage of open land was assumed to be used for such nonproductive purposes as farm roads, farmsteads, and so on. The remaining acreage was distributed among the various crops used in the analysis with the distribution based on the judgment of agricultural technicians of the USDA. It was assumed that in the B zone, the flooding-frequency conditions (overflow) would be reflected in the cropping patterns for the future without project conditions. Differences in cropping patterns between the future with project and the future without project conditions were assumed to be attributable to project development.

Assumptions concerning crop yields

Present crop yields upon which all estimated future yields were based were assumed to be flood-free yields. Estimated future yields without a project were assumed to be those that could reasonably be expected under flood-free conditions with such improved technology, farm drainage, and group drainage as could reasonably be expected without the project. All future yields estimated for a given crop on a given soil unit were assumed to vary little within the same climatic situation and over rather broad areas within a State.

Assumptions concerning forest yield

Since this study was to evaluate project influences, nonproject factors were held constant.

Forest yields were assumed to be those that could be expected with the present low level of forest management anticipated in each project area and starting with the forest stands in their existing poor condition. This level was assumed to be the same with or without project conditions as the level of forest management or timber growth was not expected to be affected by the project. In all instances, this level of management resulted in estimated yields well below the full potential. In some instances, the level of management assumed was hardly more than basic fire protection.

Even if a high level of management were assumed, the 25-year projection is too short to permit showing attainable returns from improved management of hardwood stands. Such short-term projections do not reflect the full-growth potential of the various sites because recovery from present understocking, unsatisfactory composition, and poor age-class distribution must be achieved under management before full-production possibilities can be realized. This takes time. Therefore, the short-term projections do not indicate what could be accomplished under either present low or future high levels of management.

In reviewing the tables comparing net returns from different crops, the above should be kept in mind because the values for woodland are extremely conservative and by no means portray what might eventually be expected in the way of woodland values produced under good sustained-yield management.

These assumptions and comparisons were made without reference to the future local and national requirements for high-quality hardwood logs or to the fact that the Mississippi Delta region is one of the most favored sections of the Nation for the production of quality hardwoods which it is anticipated will be in very short supply by the year 2000. Therefore, price assumptions also may be very conservative. Solution of such problems rests with land use factors and situations beyond the scope of this study.

Assumptions concerning farm and group drainage

For the future with the project it was assumed that all farms would have fully developed drainage systems so that the part of the land that would participate in the drainage development would be adequately drained It was further assumed that group-drainage facilities for the future with the project would be adequate to accommodate all excess surface water.

Assumptions concerning commodity prices and production costs

The assumptions underlying the projected commodity prices used in the evaluation study were presented in the section describing the commodity-price basic data.

In general, production costs were assumed to be straight-line inputs. Because of insufficient research data on which to base accurate estimates, no difference in costs between the various soil units was assumed. Production costs were assumed to vary with yield levels except for those items of cost considered to be fixed costs of production. Fixed costs were assumed to be constant per acre while variable costs would have a constant cost per unit of output. All costs were assumed as those under high-level management. That is, farmers would apply the technology required to obtain the yields estimated.

Crop prices and costs were based on a projected price. Forestry costs and values were assumed to be about the same as current (1955) prices; therefore current prices were used in forestry evaluations.

Limitations of the Data

USDA estimates of associated costs (land clearing, and farm and group drainage) were considered to be sufficient to provide complete drainage. Projected cropping patterns were based on flood-free conditions in the A zone. Projected cropping patterns for the B zone were somewhat less intensive because of future flooding without project and residual flooding with project. Hence, the resulting estimates of agricultural production and annual net agricultural income with project development, as presented in this report, are lower than if the entire project area studied were expected to be fully protected from flooding. If flooding in the B zone were to continue to some degree after project construction, the assumed flood-free yields would be too high and the net agricultural income shown in the report would be somewhat optimistic. Because of this, the survey data provided to the Corps require adjustment to account for residual flood hazard in the B zone.

Estimates of drainage benefits would accrue to private interests from the expenditure of funds for associated costs shown in the report. The unadjusted drainage benefits presented are not net drainage benefits because: (1) They may require adjustment downward to allow for less than complete flood protection; and (2) no Federal public costs such as are required for construction and improvement of major drainage outlets to provide for complete farm and group drainage are included. Any public costs would need to be subtracted from the drainage benefits (after adjustment) to determine net drainage benefits from the project.

The data presented cannot be considered as strictly drainage benefits since flood protection enters into some of the assumptions used in arriving at the unadjusted drainage-benefit figure. It is impossible to separate flood-control and drainage benefits except arbitrarily. In the Mississippi River and Tributaries Project evaluation, this was not necessary as the Corps required only the total benefit. It was the objec-

tive of USDA to provide the Corps with data which, in turn, could be adjusted on the basis of their hydrologic studies, from which they could determine total project benefits. As a result, this evaluation study cannot be labeled strictly a drainage-benefit evaluation. Neither can it be interpreted as a full benefit evaluation because it does not include flood-damage reduction benefits. This report is more appropriately a compilation of agricultural-economic data from which project benefits can be determined by the application of certain hydrologic determinations.

Bayou Meto Basin

This project (fig. 18) consists of improvements of Bayou Meto and its tributaries: Little Bayou Meto, Salt and Wabbaseka Bayous, and Bradley Slough; and Caney and Indian Bayous, which are extensions of Salt and Wabbaseka Bayous, respectively.

The project proposes realignment and enlargement of the channels of these streams. It is designed to alleviate the existing flood hazard and to provide major drainage outlets for farm and group drainage systems for 622,700 acres. Above the contour of the flood of record[19] is a flood-free area of 388,400 acres. A part of this acreage, however, would benefit from drainage provided by the proposed project. Situated between the contour of the flood of record and the 3-year flood-frequency contour are 199,200 acres affected by flooding that could be alleviated by proposed project works.[20] Subject to flooding by local water of such frequency as to preclude further agricultural development except for minor woodland conversions along the higher elevations are 35,100 acres.[21] This low area would not benefit from drainage. Some farm and group drainage work has been done by using this large low area, dedicated mainly to recreation as a public shooting ground, as a sump for dumping accumulated excess surface water from parts of the higher lands above it. But this solution has limited application because the sump area is inadequate for these accumulations during the growing season, when adequate

[19] This area is designated as the A zone.

[20] This area is designated as the B zone.

[21] This low sump area is designated as the C zone.

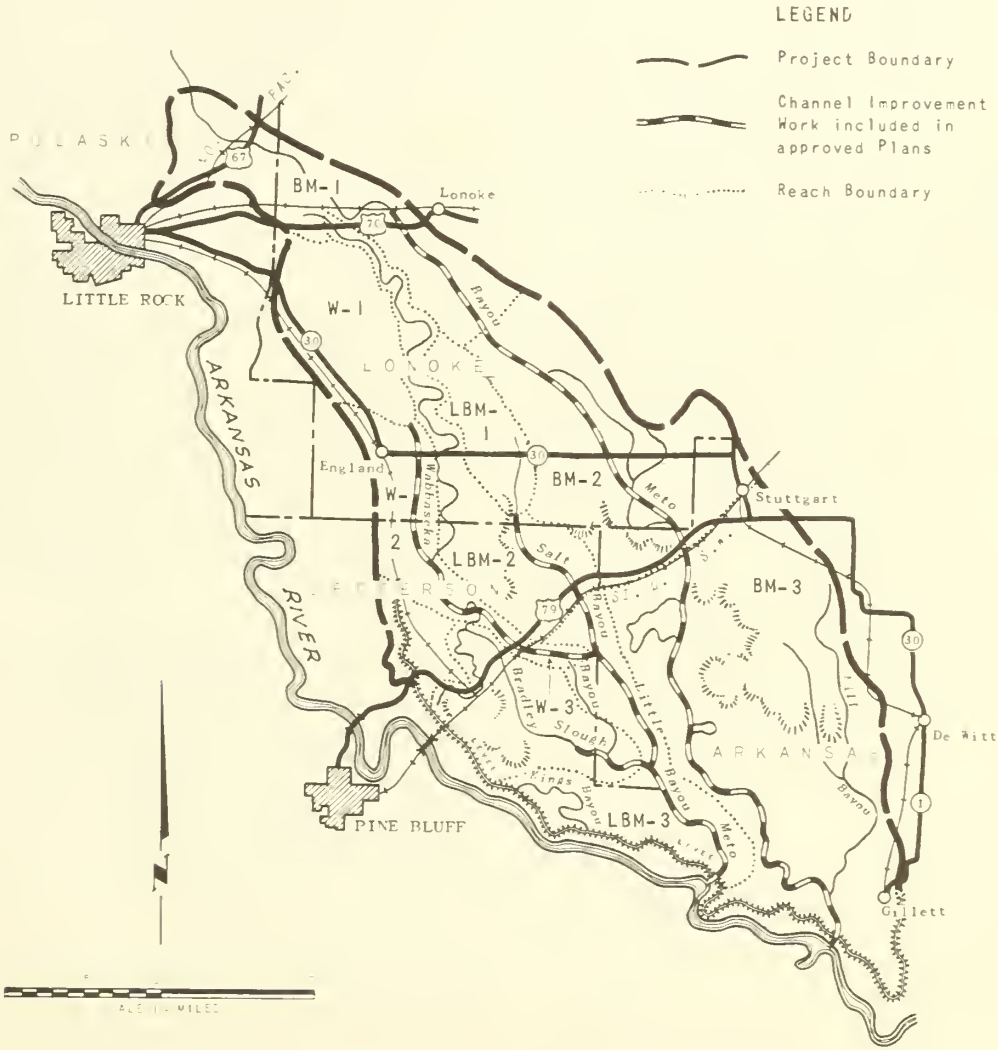


Figure 18.--Project area location, Bayou Meto Basin, Arkansas.

drainage is most important, without excessive damage to woodland and wildlife as well as to crops.

The project lands consist of Arkansas River bottom lands and loess terrace. The latter is commonly known in the area as the Grand Prairie. General farming predominates; cotton, rice, soybeans, small grain, and feed crops are the major enterprises. Although individual operating units throughout the basin are highly developed, the area as a whole has been only moderately developed. The flat topography, the poorly drained soils, the considerable area subject to floods of varying frequencies, and the present inadequacy of the major drainage outlets have contributed to the relatively low agricultural development in the area.

Of the project area, about 64 percent is open land, 29 percent is woodland, 6 percent is in the Bayou Meto Public Shooting Ground, about 1 percent is watered area, and a negligible percentage is in urban development.

Bottom-land soils are of major importance in the project area; they comprise about 70 percent of the total land area. The loess terrace makes up the remaining 30 percent; for the most part, it occurs above the zone of overflow. The soil complexity of the area in age, origin, elevation, and physical characteristics means considerable variation throughout the basin in adaptability and response to cropping systems and management.

About 31 percent of the project area is composed of very slowly permeable, poorly drained clay soils of the bottom lands. These soils are the most underdeveloped for agricultural production. Because of the flat to depressed topography, during periods of excessive rainfall which usually occurs several times each cropping season, surface flooding and waterlogging prevail unless intensive farm and group drainage systems are provided. In the flood-free state, these soils are inherently productive, and substantial yield increments could be expected from drainage improvements.

About 5 percent is composed of slowly permeable, poorly to moderately well-drained clay soils of the bottom lands. These soils are usually moderately well developed for agricultural production, depending upon location and character of adjacent soils. They respond with high production increments to drainage improvements. Intensive farm and group drainage systems are required to prevent surface flooding during excessive rainfall.

Poorly drained loams of the bottom lands constitute about 5 percent. Except for minor areas in which farm drainage systems have been installed, these soils are poorly developed for agricultural production. Because they occur in low-lying areas, surface flooding and waterlogging are serious problems.

Sandy loams of the bottom lands predominate on about 21 percent. They are underlain at varying depths with clays and heavy silt loams and are moderately well drained. They are moderately well developed agriculturally and produce fairly high yields. Inherently, these are the best soils of the bottom lands, and with intensive farm drainage and normal management, they are capable of the highest production levels of the area.

About 8 percent is composed of well-drained bottom-land soils. Normally, these soils require no drainage improvements because of their permeable structure and slightly higher elevation than the surrounding wet soils.

About 19 percent is made up of silt loam soils of the loess terrace. In general, these soils are above the zone of overflow and are moderately well developed agriculturally. The surface soils are mainly of aeolian origin and are underlain at varying depths of 10 to 30 inches by clays and heavy silt loams of alluvial origin. They are particularly well adapted to rice culture. These soils are moderately well drained and fairly productive. They respond well to drainage, especially when it is combined with good management.

The remaining 11 percent is composed of sloping lands of loess terrace. These soils are well drained and normally need no drainage improvement. Yields are comparatively low, but application of available technology and intensive management will bring about fairly high yields.

USDA estimated that with adequate flood protection and adequate farm and group drainage, 95 percent of all land in the A zone, 77 percent of all land in the B zone, and 16 percent of all land in the C zone would be open land with the project. Of the 388,400 acres in the A zone that lie above the contour of the flood of record, 86 percent is expected to have adequate drainage under the project. Of the 199,200 acres in the B zone that are subject to flooding to some degree, 76 percent is expected to have adequate drainage with the project. None of the land in the C zone, which is in a low sump area, is expected to be drained by the project works. The estimated changes in major land use and drainage by soil units in each of the zones are shown in table 16.

It is anticipated that if adequate flood protection and adequate farm and group drainage systems were provided, overall agricultural production could be increased 47 percent and total annual net agricultural income 44 percent. These increases would result from changes in major land use and in cropping systems (tables 17 and 18). Tables 17 and 18 show the expected changes in cropping systems, production, and net annual farm income resulting from project construction that would provide adequate flood protection and drainage.

An estimated 75,300 of 81,100 acres of woodland converted, if the proposed flood control-drainage project were installed, would be drained. Farmland (including the drained converted woodland) to the extent of 243,200 acres is expected to be drained with the project. The cost of woodland conversions and farm and

TABLE 16.--Bayou Meto Basin: Major land use and drainage, present and estimated future without and with project, soil units and zones

Item	All land in zone			Percentage of zone in--						Percentage of open land drained[1]		
				Open land			Woodland					
	A	B	C	A	B	C	A	B	C	A	B	C
	100 acres	*100 acres*	*100 acres*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Soil unit 1:												
Present..................	595	1,051	284	65	33	7	35	67	93	9	6	0
Without project..........	595	1,051	284	68	39	14	32	61	86	16	12	0
With project.............	595	1,051	284	88	73	14	12	27	86	77	72	0
Soil unit 2:												
Present..................	253	56	0	85	83	--	15	17	--	6	3	--
Without project..........	253	56	0	87	83	--	13	17	--	13	12	--
With project.............	253	56	0	95	86	--	5	14	--	79	72	--
Soil unit 4:												
Present..................	895	413	29	89	66	43	11	34	57	5	3	0
Without project..........	895	413	29	91	70	49	9	30	51	16	15	0
With project.............	895	413	29	98	93	49	2	7	51	81	75	0
Soil unit 6:												
Present..................	44	131	25	60	29	1	40	71	99	8	2	0
Without project..........	44	131	25	63	32	6	37	68	94	21	12	0
With project.............	44	131	25	84	75	6	16	25	94	80	74	0
Soil unit 8:												
Present..................	48	52	0	75	22	--	25	78	--	0	0	--
Without project..........	48	52	0	80	25	--	20	75	--	15	5	--
With project.............	48	52	0	95	49	--	5	51	--	78	71	--
Soil unit 9:												
Present..................	394	122	0	85	46	--	15	54	--	97	100	--
Without project..........	394	122	0	85	52	--	15	48	--	98	100	--
With project.............	394	122	0	85	70	--	15	30	--	99	100	--
Soil unit 10:												
Present..................	1,200	134	0	97	61	--	3	39	--	13	67	--
Without project..........	1,200	134	-0	98	64	--	2	36	--	30	3	--
With project.............	1,200	134	0	99	79	--	1	21	--	85	90	--
Soil unit 11:												
Present..................	455	33	13	94	71	0	6	29	100	100	100	0
Without project..........	455	33	13	94	73	10	6	27	90	100	100	0
With project.............	455	33	13	94	84	10	6	16	90	100	100	0
All:												
Present..................	3,884	1,992	351	87	44	10	13	56	90	30	19	0
Without project..........	3,884	1,992	351	88	49	16	12	51	84	39	26	0
With project.............	3,884	1,992	351	95	77	16	5	23	84	86	76	0

[1] Includes naturally and artificially drained land.

TABLE 17.--Bayou Meto Basin: Estimated effects of project development on cropping systems[1]

Crop	Percentage change in acreage			Percentage change in production			Percentage change in net return		
	A zone	B zone	All land	A zone	B zone	All land	A zone	B zone	All land
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Cotton....................	18	119	39	48	211	74	60	262	86
Corn......................	-5	-17	-9	11	3	8	10	9	10
Rice......................	3	36	8	16	52	22	48	91	54
Soybeans..................	4	56	14	15	72	26	20	79	32
Oats......................	-11	25	0	3	55	20	-12	75	22
Oats pasture..............	-20	30	-9	28	21	26	22	23	23
Grain sorghum.............	-23	-20	-18	-17	-11	-12	-13	-5	-12
Permanent pasture.........	3	26	9	33	154	38	38	58	43
Idle......................	4	29	11	--	--	--	--	--	--
Other.....................	7	59	19	--	--	--	--	--	--
Woodland..................	-53	-56	-46	-54	-28	-46	-67	-35	-35
All land..............	0	0	0	33	109	47	40	73	44

[1] No change in acreage, production, or net return in C zone. "All land" includes C zone.

TABLE 18.--Bayou Meto Basin: Estimated future crop acreages, crop production, and net return without and with project development

Crop	Without project			With project			Difference in net return	Percentage increase in net return
	Acres	Production[1]	Net return	Acres	Production[1]	Net return		
	100 acres	*1,000 units*	*1,000 dollars*	*100 acres*	*1,000 units*	*1,000 dollars*	*1,000 dollars*	*Percent*
Cotton................	1,325	127	2,763	1,841	222	5,141	2,378	86
Corn..................	101	411	235	92	443	258	23	10
Rice..................	867	2,590	1,113	934	3,151	1,717	604	54
Soybeans..............	800	1,631	1,649	913	2,062	2,172	523	32
Oats..................	307	839	175	308	1,008	214	39	22
Oats pasture..........	[2] (182)	1,531	181	(165)	1,931	222	41	23
Grain sorghum.........	71	149	92	58	131	81	-11	-12
Permanent pasture.....	285	7,306	456	310	10,079	652	196	43
Idle..................	265	--	--	295	--	--	--	--
Other.................	437	--	--	518	--	--	--	--
Woodland..............	1,769	--	808	958	--	528	-280	-35
Total............	6,227	--	7,472	6,227	--	10,985	3,513	44

[1] Cotton--500-pound bales; corn, soybeans, oats, and grain sorghum--bushels; rice--hundredweights; beef--pounds.
[2] Duplicated acreage.

group drainage system installation associated with project construction was estimated at $10,791,200, with the annual equivalent at $1,352,000.[22]

As shown in table 19, the annual increase in net agricultural income was estimated at $3,513,000. The discount value of estimated annual increase in net agricultural income and of estimated annual equivalent associated costs are $1,999,000 and $826,000 respectively.

TABLE 19.--Bayou Meto Basin: Project summary

Item	Amount
Drainage operations:	
Woodland converted to open cropland	*Acres* 81,100
Farmland drained	243,200
Associated costs:	
Initial:	*Dollars*
Woodland conversion	4,922,300
Farm drainage installations	3,218,600
Group drainage installations	2,650,300
Total associated costs	10,791,200
Annual equivalent:	
Conversion	287,200
Farm drainage	416,800
Group drainage	315,600
Annual farm drainage maintenance	332,400
Total annual costs	1,352,000
Annual increase in net farm income	3,513,000
Discounted value of:	
Annual increase in net farm income	1,999,000
Annual associated costs	826,000
Unadjusted benefits	1,173,000

Big Creek Basin

The Big Creek Basin Project (fig. 19) consists of channel straightening, cleanout, and enlargement of Big Creek and its major tributaries. The proposed project is designed to serve as a major drainage outlet for farm and group drainage systems for an area about 1,050 square miles. An area of 551,100 acres lies above the contour of the flood of record; 104,800 acres are affected by flooding that can be alleviated by project works; and 17,000 acres are subject to backwater flooding from the White River of such frequency as to preclude further agricultural development and which would not be benefited by project drainage.

About 61 percent of the area is open land, 38 percent is wooded, and 1 percent is urban area or is watered. There is a much higher percentage of woodland on the heavy wet soils in the area than on the better drained soils.

[22] Includes annual drainage maintenance cost.

Soils of Crowley's Ridge, comprising about 2 percent of the area, are above the zone of overflow and are in no way affected by the project. They do have a bearing on the project, however, due to the rapid rate of runoff and the associated high rate of sediment production characteristic of soils of aeolian origin. The runoff and sediment increase the costs of farm and group drainage installation and maintenance considerably in those reaches of the project having portions of Crowley's Ridge in their headwaters.

About 18 percent is composed of sandy loam and silt loam soils. These are well drained, normally requiring no drainage improvements either because of slope or because of permeable structure. These soils are presently highly productive and are well developed agriculturally.

Sandy loams and silt loams predominate on about 57 percent. They are underlain with heavy clays of alluvial origin; the surface soils are of both alluvial and aeolian origin. These soils are poorly to moderately well drained and fairly highly developed, giving moderately high production. They have a high response to drainage, some of them being the most productive in the area when drained and properly managed.

About 18 percent is composed of poorly drained silt loam bottom-land soils. These soils are similar, in most respects, to the bottom-land clays except that they have a somewhat higher productivity potential.

The remainder of the area, comprising some 5 percent consists of poorly drained bottom-land clay soils. These soils are poorly to moderately well developed for agricultural production at present but respond with high production increments to drainage improvement. These soils experience surface flooding and waterlogging several times each year during the cropping season because of the flat topography which inhibits surface drainage.

USDA estimated that with adequate flood protection and adequate farm and group drainage, 94 percent of all land in the A zone, 84 percent of all land in the B zone, and 25 percent of all land in the C zone would be open land. Of the 551,000 acres in the A zone, 83 percent is expected to have adequate drainage if the project were installed. Of the 104,800 acres in the B zone, which is subject to flooding to some extent, 77 percent is expected to have adequate drainage. None of the land in the C zone is anticipated to be drained. The estimated changes in major land use and drainage by soil units in each of the zones is shown in table 20.

USDA anticipates that if adequate flood protection and farm and group drainage were installed, overall agricultural production in the Big Creek Basin could be increased 70 percent and total net annual agricultural income could be increased 58 percent. These increases would result from changes in cropping systems and drainage as indicated in tables 21 and 22. Tables 21 and 22 show the expected changes in cropping systems, production, and net annual agricultural income resulting from project construction that

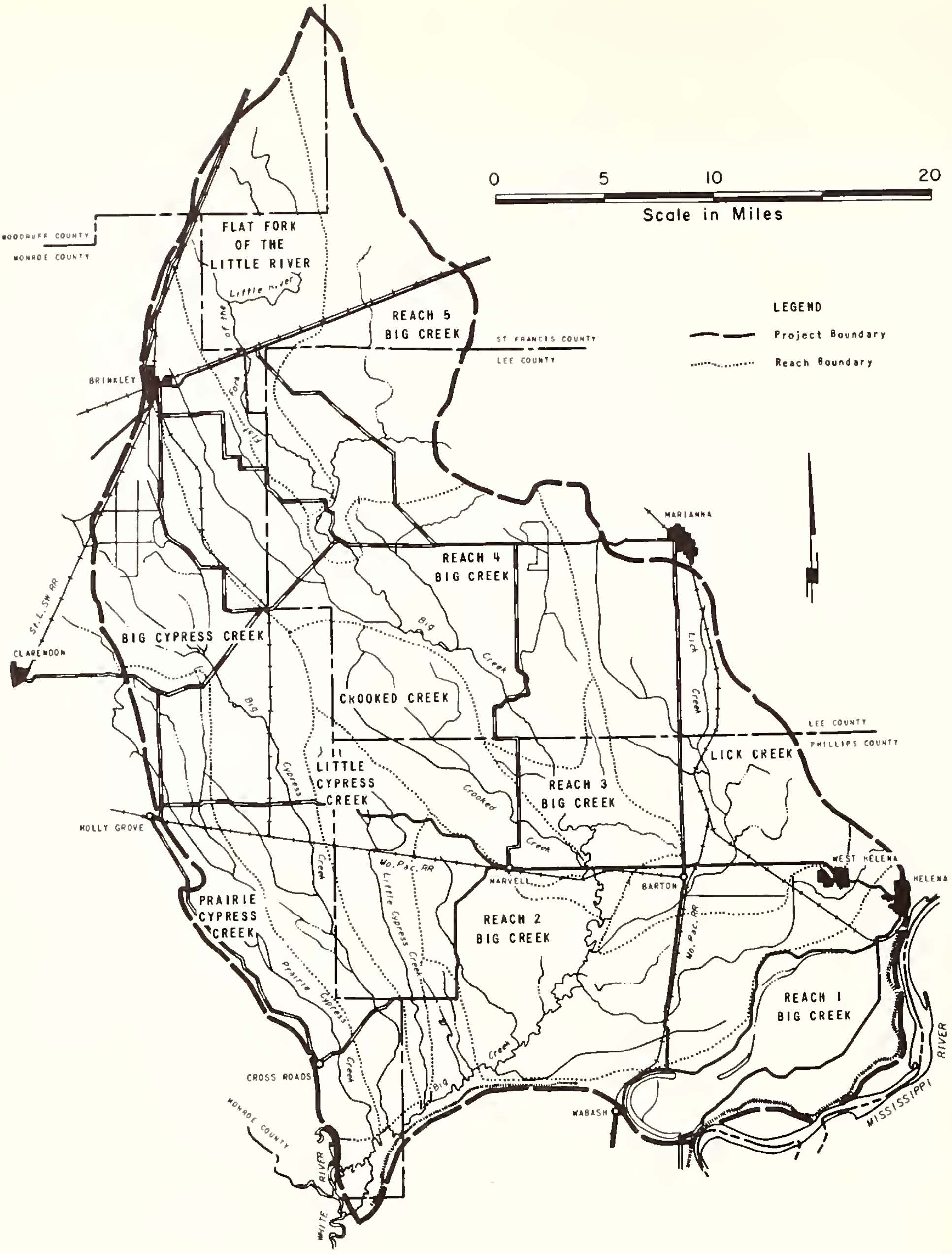


Figure 19.--Project area location, Big Creek Basin, Arkansas.

would provide adequate flood protection and drainage.

If the proposed flood control-drainage project were installed, it is anticipated that 124,500 acres of 151,800 acres of woodland converted would be drained. A total of 228,100 acres of farmland (including the converted woodland) is expected to be drained with the project. The total cost of woodland conversions and farm and group drainage systems installation associated with project construction was estimated by USDA at $16,126,000, the annual equivalent of which was estimated at $1,797,000 (including annual drainage maintenance cost).

As shown in table 23, the annual increase in net agricultural income was estimated at $3,558,000. The discounted values of annual increase in net agricultural income and of annual equivalent associated costs are $2,015,000 and $1,100,000, respectively.

TABLE 20.--Big Creek Basin: Major land use and drainage, present and estimated future without and with project, soil units and zones

Item	All land in zone			Percentage of zone in--						Percentage of open land drained[1]		
				Open land			Woodland					
	A	B	C	A	B	C	A	B	C	A	B	C
	100 acres	*100 acres*	*100 acres*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Soil unit 1:												
Present	192	21	68	61	29	3	39	71	97	12	0	0
Without project	192	21	68	62	30	14	38	70	86	34	0	0
With project	192	21	68	92	83	14	8	17	86	81	70	0
Soil unit 2:												
Present	37	8	--	87	20	--	13	80	--	26	0	--
Without project	37	8	--	87	22	--	13	78	--	55	10	--
With project	37	8	--	97	81	--	3	19	--	89	76	--
Soil unit 4:												
Present	637	147	13	78	61	60	22	39	40	5	13	0
Without project	637	147	13	80	65	72	20	35	28	23	24	0
With project	637	147	13	94	91	72	6	9	28	82	79	0
Soil unit 6:												
Present	460	354	87	37	23	7	63	77	93	15	27	0
Without project	460	354	87	39	25	26	61	75	74	26	34	0
With project	460	354	87	83	82	26	17	18	74	79	77	0
Soil unit 7:												
Present	187	53	--	83	41	--	17	59	--	1	0	--
Without project	187	53	--	83	41	--	17	59	--	5	1	--
With project	187	53	--	96	86	--	4	14	--	70	69	--
Soil unit 8:												
Present	113	178	--	20	26	--	80	74	--	0	11	--
Without project	113	178	--	26	26	--	74	74	--	7	17	--
With project	113	178	--	76	75	--	24	25	--	77	71	--
Soil unit 9:												
Present	2,490	150	--	79	58	--	21	42	--	40	36	--
Without project	2,490	150	--	87	59	--	13	41	--	49	38	--
With project	2,490	150	--	97	89	--	3	11	--	85	83	--
Soil unit 10:												
Present	1,052	88	--	51	37	--	49	63	--	5	11	--
Without project	1,052	88	--	57	39	--	53	61	--	10	15	--
With project	1,052	88	--	91	88	--	9	12	--	74	70	--
Soil unit 11:												
Present	229	49	2	77	79	48	23	21	52	100	100	0
Without project	229	49	2	100	81	48	0	19	52	100	100	0
With project	229	49	2	100	94	48	0	6	52	100	100	0
Soil unit 12:												
Present	11	--	--	99	--	--	1	--	--	100	--	--
Without project	11	--	--	100	--	--	0	--	--	100	--	--
With project	11	--	--	100	--	--	0	--	--	100	--	--
Soil unit 15:												
Present	103	--	--	44	--	--	56	--	--	100	--	--
Without project	103	--	--	93	--	--	7	--	--	100	--	--
With project	103	--	--	93	--	--	7	--	--	100	--	--
All:												
Present	5,511	1,048	170	68	39	10	32	61	90	30	28	0
Without project	5,511	1,048	170	75	41	25	25	59	75	41	33	0
With project	5,511	1,048	170	94	84	25	6	16	75	83	77	0

[1] Includes naturally and artificially drained land.

TABLE 21.--Big Creek Basin: Estimated effects of project development on cropping systems[1]

Crop	Percentage change in acreage			Percentage change in production			Percentage change in net return		
	A zone	B zone	All land	A zone	B zone	All land	A zone	B zone	All land
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Cotton	31	131	40	70	197	87	81	223	98
Corn	11	78	16	36	137	44	30	133	38
Rice	50	216	67	81	266	100	168	442	195
Soybeans	27	98	34	35	113	44	33	119	43
Oats	21	81	27	46	105	53	57	113	64
Oats pasture	21	153	29	38	166	47	30	173	39
Grain sorghum	25	0	23	33	7	30	29	136	59
Permanent pasture	18	70	22	53	117	59	51	--	--
Idle	8	34	10	--	--	--	--	--	--
Other	26	105	33	--	--	--	--	--	--
Woodland	-77	-73	-71	-76	-80	-70	-70	-79	-66
All land	0	0	0	61	138	70	53	101	58

[1] No change in acreage, production, or net return in C zone. "All land" includes C zone.

TABLE 22.--Big Creek Basin: Estimated future crop acreages, crop production, and net return without and with project development

Crop	Without project			With project			Difference in net return	Percentage increase in net return
	Acres	Production[1]	Net return	Acres	Production[1]	Net return		
	100 acres	*1,000 units*	*1,000 dollars*	*100 acres*	*1,000 units*	*1,000 dollars*	*1,000 dollars*	*Percent*
Cotton	1,759	128	2,236	2,459	239	4,432	2,196	98
Corn	285	902	522	332	1,302	721	199	38
Rice	252	696	241	420	1,389	711	470	195
Soybeans	503	1,002	1,003	676	1,447	1,437	434	43
Oats	448	1,283	318	569	1,958	521	203	64
Oats pasture	[2] (322)	3,051	349	(414)	4,476	485	136	39
Grain sorghum	56	108	62	69	141	78	16	26
Permanent pasture	486	10,843	637	594	17,380	1,014	377	59
Idle	344			380				
Other	459			611				
Woodland	2,137		715	619		242	-473	-66
Total	6,729		6,083	6,729		9,641	3,558	58

[1] Cotton--500-pound bales; corn, soybeans, oats, and grain sorghum--bushels; rice--hundredweights; beef--pounds.
[2] Duplicated acreage.

TABLE 23.--Big Creek Basin: Project summary

Item	Amount
Drainage operations:	
Woodland converted to open cropland	*Acres* 151,800
Farmland drained	228,100
Associated costs:	
Initial:	*Dollars*
Woodland conversion	8,619,100
Farm drainage installations	3,656,700
Group drainage installations	3,850,100
Total associated costs	16,125,900
Annual equivalent:	
Conversion	472,200
Farm drainage	473,500
Group drainage	448,700
Annual farm drainage maintenance	402,300
Total annual costs	1,796,700
Annual increase in net farm income	3,558,000
Discounted value of:	
Annual increase in net farm income	2,015,000
Annual associated costs	1,100,000
Unadjusted benefits	915,000

Boeuf-Tensas-Macon Basin

The overall project (fig. 20) includes the improvement of the main stems of Boeuf and Tensas Rivers and Bayou Macon and their tributaries in Arkansas and Louisiana. The Arkansas part of the project would consist of stream and channel improvements and extensions to existing channel works and is designed to improve existing major drainage outlets for farm and group drainage systems for 116,700 acres. The area includes 35,500 acres above the contour of the flood of record, 66,900 acres subject to flooding which would be alleviated by the proposed project works, and 14,300 acres lying below the 3-year flood frequency contour which would not benefit by project drainage.

About 43 percent is open land, 56 percent is woodland, and 1 percent, exclusive of Lake Chicot proper, is watered.

The soils of the Boeuf-Tensas-Macon Basin in Arkansas are comprised wholly of sediments from the Mississippi River and its tributaries. When properly managed and drained, they have high production levels. About 84 percent of the area is comprised of poorly drained bottom-land clay soils. These soils are poorly developed agriculturally but have some of the highest yield responses to drainage of any soils studied. They are inherently productive, and high yields of adapted crops can be regularly obtained when surface-water accumulations are rapidly removed.

Sandy loams predominate on about 10 percent of the area, occurring at intermediate elevations as low terraces. These soils are poorly to moderately well drained and consequently are fairly well developed agriculturally.

The remaining 6 percent is comprised of well drained sandy loam bottom-land soils, which occur as natural levees along major streams. These soils normally require no drainage improvements because of the permeable structure and somewhat higher elevations. They are well developed agriculturally and are highly productive.

If adequate flood protection and drainage were provided, presumably 95 percent of all land in the A zone, 84 percent of all land in the B zone, and 24 percent of all land in the C zone would be open land. The changes in major land use and in the percentage of land drained, by soil units, estimated by USDA to occur under the assumed conditions are shown in table 24.

As shown in tables 25 and 26, net annual agricultural income is expected to increase 79 percent and total agricultural production 69 percent if project works are installed to provide adequate flood protection and drainage.

Under the proposed flood control-drainage project, 5,400 acres of woodland are expected to be converted and drained. A total of 17,700 acres of farmland (including the converted woodland) would be drained. The total associated cost--for woodland conversion and farm and group drainage systems--was estimated by USDA at $562,500, with the annual equivalent at $68,800 (including annual drainage maintenance cost).

As shown in table 27, the annual increase in net agricultural income attributable to the project was estimated at $229,800. The discounted values of annual increase in net agricultural income and of annual equivalent associated costs are estimated at $159,000 and $50,000, respectively.

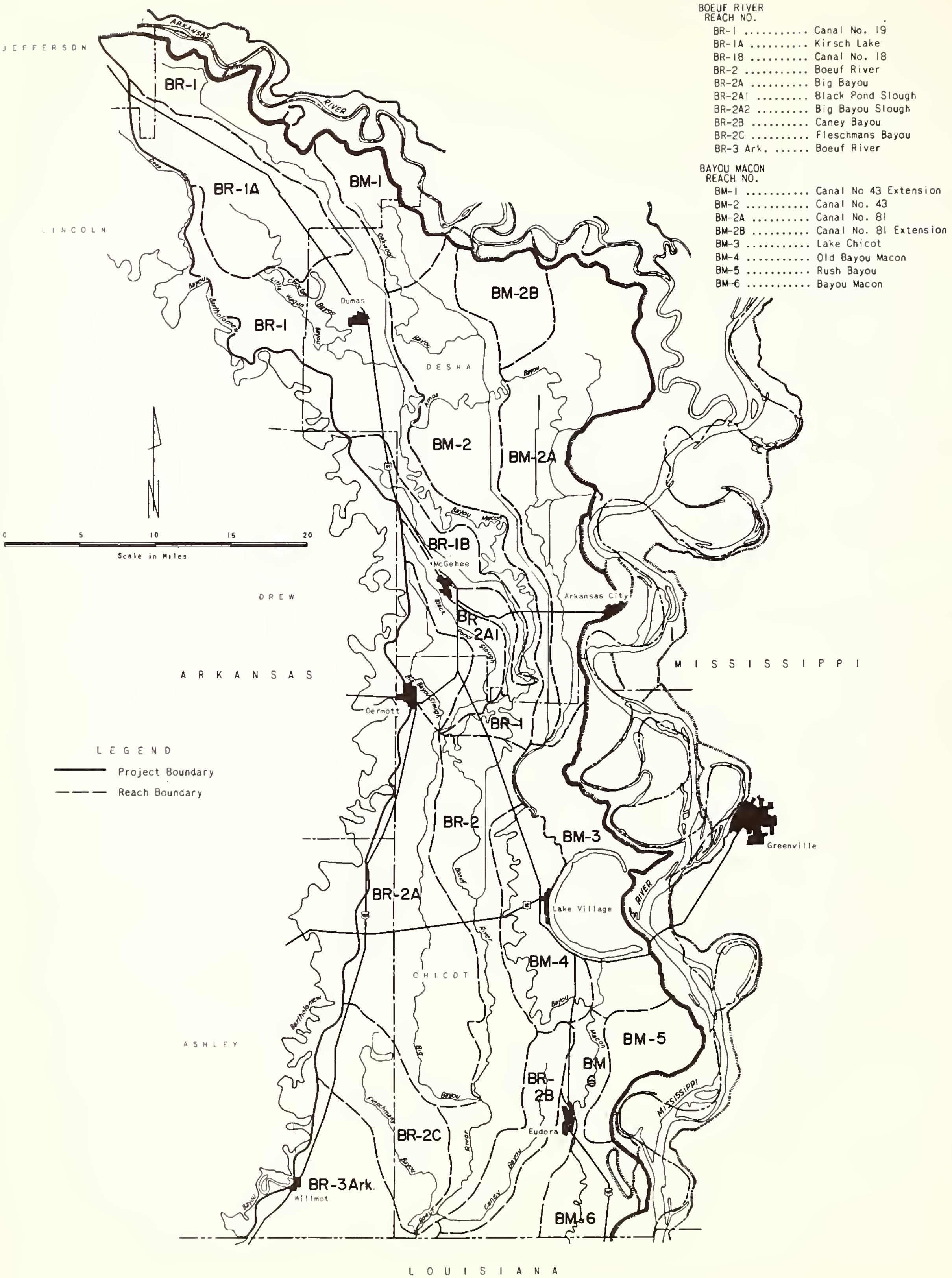


Figure 20.--Project area location, Boeuf-Tensas-Macon Basin, Arkansas.

TABLE 24.--Boeuf-Tensas-Macon Basin: Major land use and drainage, present and estimated future without and with project, soil units and zones

Item	All land in zone			Percentage of zone in--						Percentage of open land drained[1]		
				Open land			Woodland					
	A	B	C	A	B	C	A	B	C	A	B	C
	100 acres	*100 acres*	*100 acres*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Soil unit 1:												
Present.................	132	633	143	50	31	21	50	69	79	6	1	0
Without project.........	132	633	143	95	58	24	5	42	76	12	3	0
With project............	132	633	143	95	83	24	5	17	76	75	76	0
Soil unit 2:												
Present.................	57	32		75	76		25	24		1	0	
Without project.........	57	32		98	87		2	13		14	0	
With project............	57	32		98	96		2	4		82	86	
Soil unit 4:												
Present.................	84	4		90	92		10	8		7	0	
Without project.........	84	4		99	97		1	3		30	0	
With project............	84	4		99	0		1	1		87	80	
Soil unit 6:												
Present.................	13			44			56			0		
Without project.........	13			94			6			0		
With project............	13			94			6			60		
Soil unit 11:												
Present.................	56			90			10			100		
Without project.........	56			90			10			100		
With project............	56			90			10			100		
Soil unit 12:												
Present.................	13			92			8			100		
Without project.........	13			92			8			100		
With project............	13			92			8			100		
All:												
Present.................	355	669	143	71	33	21	29	67	79	29	1	0
Without project.........	355	669	143	95	60	24	5	40	76	33	3	0
With project............	355	669	143	95	84	24	5	16	76	83	76	0

[1] Includes naturally and artificially drained land.

TABLE 25.--Boeuf-Tensas-Macon Basin: Estimated effects of project development on cropping systems[1]

Crop	Percentage change in acreage			Percentage change in production			Percentage change in net return		
	A zone	B zone	All land	A zone	B zone	All land	A zone	B zone	All land
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Cotton	33	188	82	64	394	133	80	1,820	93
Corn.....................	0	200	28	14	297	42	14	383	50
Rice.....................	4	70	46	14	91	63	39	145	104
Soybeans.................	-12	37	6	-5	80	18	-3	105	24
Oats.....................	0	1,185	83	16	155	102	17	4,689	100
Oats pasture.............	0		91	21	100	76	17		78
Grain sorghum............	9	345	66	20	412	82	26	469	88
Permanent pasture........	-7	199	47	20	380	92	24	380	93
Idle.....................	-37	-65	-54						
Other....................	0	39	20						
Woodland.................	0	-59	-40	0	-59	-37	0	-59	-37
All land...............	0	0	0	27	116	69	31	159	79

[1] No change in acreage, production, or net return in C zone. "All land" includes C zone.

TABLE 26.--Boeuf-Tensas-Macon Basin: Estimated future crop acreages, crop production, and net return without and with project development

Crop	Without project			With project			Difference in net return	Percentage increase in net return
	Acres	Production[1]	Net return	Acres	Production[1]	Net return		
	100 acres	*1,000 units*	*1,000 dollars*	*100 acres*	*1,000 units*	*1,000 dollars*	*1,000 dollars*	*Percent*
Cotton..............	74	4	104	134	13	305	201	93
Corn................	10	39	22	13	55	33	11	50
Rice................	238	725	315	347	1,399	644	329	104
Soybeans............	82	168	174	87	199	215	41	24
Oats................	7	28	8	14	56	16	8	100
Oats pasture........	[2] (7)	82	9	(13)	144	16	7	78
Grain sorghum.......	21	43	25	35	78	47	22	88
Permanent pasture....	86	1,818	113	126	3,491	218	105	93
Idle................	179			83				
Other...............	78			94				
Woodland............	392		102	234		64	-38	-37
Total...........	1,167		872	1,167		1,558	686	79

[1] Cotton--500-pound bales; corn, soybeans, oats, and grain sorghum--bushels; rice--hundredweights; beef--pounds.
[2] Duplicated acreage.

TABLE 27.--Boeuf-Tensas-Macon Basin, Arkansas: Project summary

Item	Total amount in project area	Amount attributable to proposed project
Drainage operations:		
	Acres	
Woodland converted to open cropland	15,800	5,400
Farmland drained	52,900	17,700
Associated costs:		
Initial:	*Dollars*	
Woodland conversion	777,300	258,000
Farm drainage installations	623,000	208,700
Group drainage installations	286,100	95,800
Total associated costs	1,686,400	562,500
Annual equivalent:		
Conversion	42,600	14,300
Farm drainage	80,700	27,000
Group drainage	32,800	11,000
Annual farm drainage maintenance	49,200	16,500
Total annual costs	205,300	68,800
Annual increase in net farm income	686,000	229,800
Discounted value of:		
Annual increase in net farm income	473,000	159,000
Annual associated costs	148,000	50,000
Unadjusted benefits	325,000	109,000

Cache River Basin

The project proposed in the Cache River Basin (fig. 21) consists of channel enlargements and realignment for Cache River and Bayou DeView. It is designed to serve as major outlets for farm and group drainage systems for about 2,014 square miles. About 821,800 acres lie above the limits of overflow, 426,900 acres are affected by flooding that could be alleviated by the proposed project, and 40,000 acres are subject to backwater flooding from the White River. The latter acreage would not benefit from project drainage.

The project area exclusive of Crowley's Ridge contains about 54 percent open land, 45 percent woodland, and less than 1 percent each of urban and watered areas.

Cropping patterns on open land vary chiefly with the soils and with drainage improvement of the wetland soils. Much of the cropland in the zone subject to flooding is along the upper limits of overflow, where frequency, depth, and duration are not great enough to affect cropping seriously.

Cotton, rice, soybeans, corn, oats, grain sorghum, and pasture represent the major crops grown in the basin.

Soils are very complex in age, origin, adaptability, and response to cropping systems and management. Soils of Crowley's Ridge, which comprises about 12 percent of the basin area, are above the zone of overflow and are not affected by the project. But they have a bearing on the project because of their contribution of sediment.

About 6 percent of the area is composed of poorly drained bottom-land clay soils. At present, these soils are the most poorly developed agriculturally of any soils in the area. They are subject to overflow and waterlogging during a good part of the cropping season each year.

About 21 percent is composed of poorly drained silt loam bottom-land soils. These soils are similar to the bottom-land clays except that they have a slightly higher productivity potential.

Sandy and silt loams predominate on about 52 percent of the area. They are underlain with heavy clays of alluvial origin; the surface soils are of both alluvial and aeolian origin. These soils occupy low terraces and are particularly adapted to rice culture.

The remaining 9 percent is composed of sandy loam and silt loam soils. Normally, these soils require no drainage improvements. The bottom-land and low-terrace soils in this group are highly productive and well developed agriculturally.

USDA estimated that if adequate flood protection and drainage were provided, 85 percent of all land in the A and B zones and 2 percent of all land in the C zone would be open land. The changes in major land use and in percentage of land drained, by soil units, expected to occur with project development under assumptions of adequate flood protection and drainage, are shown in table 28.

As indicated in tables 29 and 30, net annual agricultural income in the Cache River Basin is expected to increase 77 percent and total agricultural production 91 percent with project development.

If the proposed flood control-drainage project were installed, it is expected that 285,300 acres of woodland of 318,400 acres converted would be drained. A total of 532,800 acres of farmland (including the converted woodland) is expected to be drained with the project. The associated cost--of woodland conversions, farm drainage systems, and group drainage systems--was estimated by USDA at $34,347,500, with the annual equivalent (including annual drainage maintenance cost) at $3,746,600.

As shown in table 31, the annual increase in net agricultural income was estimated at $6,817,000. The discounted values of annual increase in net agricultural income and of annual equivalent associated costs are estimated at $3,759,000 and $2,316,300, respectively.

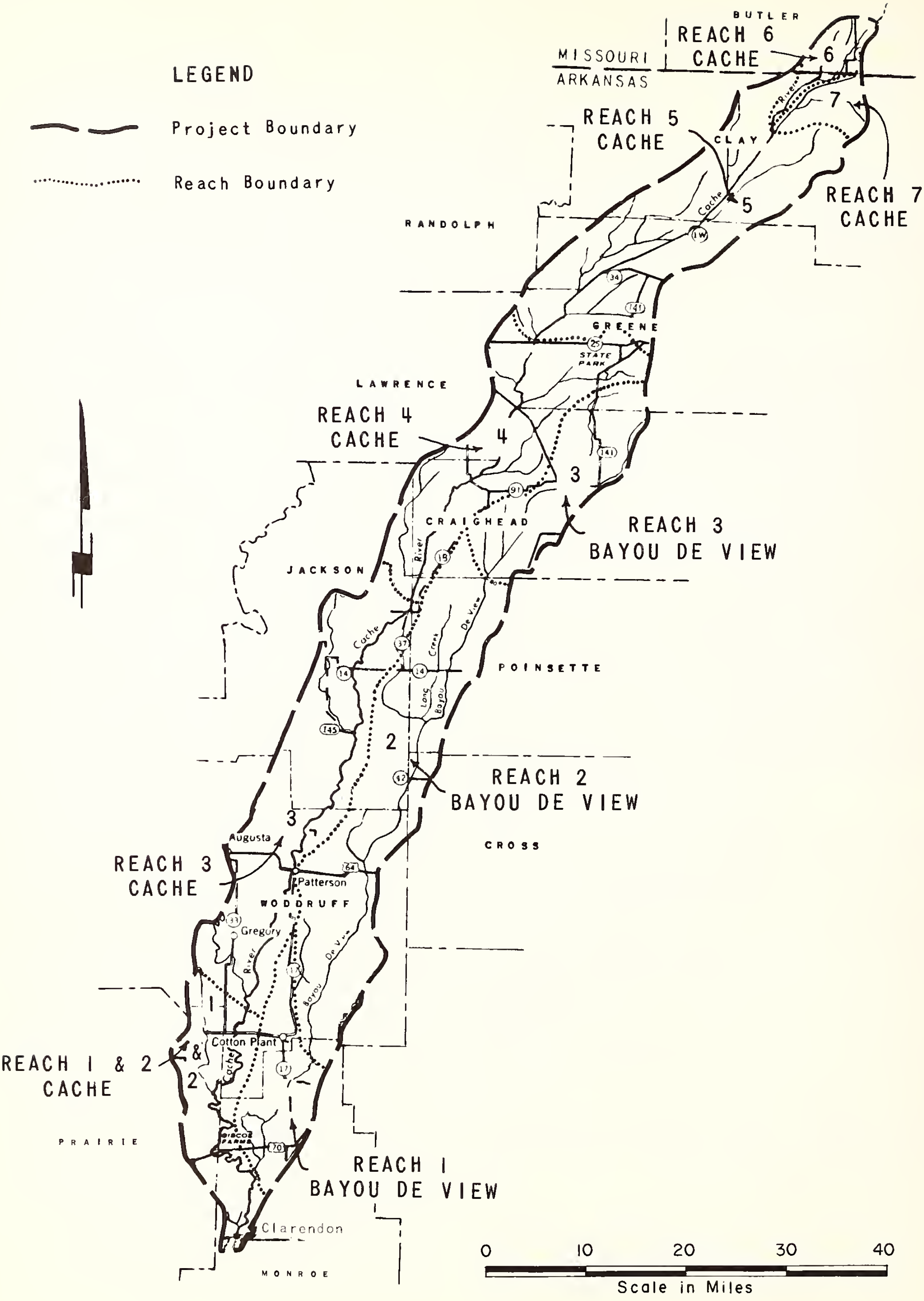


Figure 21.--Project area location, Cache River Basin.

TABLE 28.--Cache River Basin: Major land use and drainage, present and estimated future without and with project, soil units and zones

Item	All land in zone			Percentage of zone in--						Percentage of open land drained[1]		
				Open land			Woodland					
	A	B	C	A	B	C	A	B	C	A	B	C
	100 acres	*100 acres*	*100 acres*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Soil unit 1:												
Present.................	21	331	314	84	42	1	16	58	99	9	13	0
Without project.........	21	331	314	84	45	1	16	55	99	15	16	0
With project............	21	331	314	98	89	1	2	11	99	86	80	0
Soil unit 2:												
Present.................		81	15		50	11		50	89		30	0
Without project.........		81	15		53	11		47	89		34	0
With project............		81	15		90	11		10	89		84	0
Soil unit 4:												
Present.................	573	480		75	57		25	43		16	21	
Without project.........	573	480		78	59		22	41		20	25	
With project............	573	480		95	92		5	8		83	85	
Soil unit 6:												
Present.................	654	1,654	68	38	25	4	62	75	96	4	12	0
Without project.........	654	1,654	68	41	27	4	59	73	96	11	16	0
With project............	654	1,654	68	86	81	4	14	19	96	73	80	0
Soil unit 7:												
Present.................	238	8		85	48		15	52		10	0	
Without project.........	238	8		93	53		7	47		23	5	
With project............	238	8		97	86		3	14		59	51	
Soil unit 8:												
Present.................	273	198		66	31		34	69		1	4	
Without project.........	273	198		68	34		32	66		8	9	
With project............	273	198		90	77		10	23		74	74	
Soil unit 9:												
Present.................	1,110	137	2	86	69	7	14	31	93	43	65	0
Without project.........	1,110	137	2	86	71	7	14	29	93	48	71	0
With project............	1,110	137	2	92	94	7	8	6	93	86	94	0
Soil unit 10:												
Present.................	3,503	1,318		63	40		37	60		8	9	
Without project.........	3,503	1,318		67	49		33	51		20	20	
With project............	3,503	1,318		92	84		8	16		79	77	
Soil unit 11:												
Present.................	329	62	1	88	93	4	12	7	96	100	100	100
Without project.........	329	62	1	88	93	4	12	7	96	100	100	100
With project............	329	62	1	88	99	4	12	1	96	100	100	100
Soil unit 15:												
Present.................	1,517			57			43			100		
Without project.........	1,517			57			43			100		
With project............	1,517			57			43			100		
All:												
Present.................	8,218	4,269	400	66	38	2	34	62	98	31	19	0
Without project.........	8,218	4,269	400	68	42	2	32	58	98	36	25	0
With project............	8,218	4,269	400	85	85	2	15	15	98	82	81	0

[1] Includes naturally and artificially drained land.

TABLE 29.--Cache River Basin: Estimated effects of project development on cropping systems[1]

Crop	Percentage change in acreage			Percentage change in production			Percentage change in net return		
	A zone	B zone	All land	A zone	B zone	All land	A zone	B zone	All land
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Cotton....................	23	119	42	71	222	105	82	272	129
Corn......................	-2	77	14	17	152	44	26	167	54
Rice......................	71	120	88	116	146	127	237	225	232
Soybeans..................	23	114	49	42	154	74	42	174	80
Oats......................	39	105	54	95	179	116	128	228	155
Oats pasture..............	68	114	81	154	177	161	114	162	130
Grain sorghum.............	55	89	62	248	90	214	55	91	63
Permanent pasture.........	9	50	20	55	120	74	53	136	78
Idle......................	11	25	15						
Other.....................	25	100	43						
Woodland..................	-53	-73	-58	-49	-64	-45	-38	-74	-71
All land..............	0	0	0	66	157	91	57	135	77

[1] No change in acreage, production, or net return in C zone. "All land" includes C zone.

TABLE 30.--Cache River Basin: Estimated future crop acreages, crop production, and net return without and with project development

Crop	Without project			With project			Difference in net return	Percentage increase in net return
	Acres	Production[1]	Net return	Acres	Production[1]	Net return		
	100 acres	*1,000 units*	*1,000 dollars*	*100 acres*	*1,000 units*	*1,000 dollars*	*1,000 dollars*	*Percent*
Cotton..............	2,604	169	2,405	3,709	346	5,501	3,096	129
Corn................	421	1,286	698	479	1,851	1,077	379	54
Rice................	629	1,714	575	1,182	3,888	1,910	1,335	232
Soybeans............	1,489	2,667	2,526	2,213	4,652	4,554	2,028	80
Oats................	291	730	163	448	1,578	416	253	155
Oats pasture........	[2] (147)	1,052	125	(267)	2,751	287	162	130
Grain sorghum.......	119	224	124	193	705	202	78	63
Permanent pasture....	516	10,959	630	621	19,028	1,119	489	78
Idle................	614			704				
Other...............	742			1,060				
Woodland............	5,462		1,652	2,278		649	-1,003	-71
Total...........	12,887		8,898	12,887		15,715	6,817	77

[1] Cotton--500-pound bales; corn, soybeans, oats, and grain sorghum--bushels; rice--hundredweights; beef--pounds.
[2] Duplicated acreage.

TABLE 31.--Cache River Basin: Project summary

Item	Amount
Drainage operations:	*Acres*
Woodland converted to open cropland.	318,400
Farmland drained..................	532,800
Associated costs:	
Initial:	*Dollars*
Woodland conversion..............	18,714,600
Farm drainage installations.......	6,884,400
Group drainage installations......	8,748,500
Total associated costs...........	34,347,500
Annual equivalent:	
Conversion.......................	1,025,200
Farm drainage....................	891,500
Group drainage...................	1,056,400
Annual farm drainage maintenance...	773,500
Total annual costs...............	3,746,600
Annual increase in net farm income..	6,817,000
Discontinued value of:	
Annual increase in net farm income.	3,759,000
Annual associated costs...........	2,316,000
Unadjusted benefits..............	1,443,000

Dials Creek Basin

This project (fig. 22) consists of channel straightening, cleanout, and enlargement of portions of Dials Creek. The proposed project is designed to serve as a major outlet for farm and group drainage systems for about 47 square miles. Lying above the contour of the flood of record (the A zone), are 24,400 acres which are not subject to flooding but could benefit from drainage development. An area of 2,800 acres subject to flooding could be alleviated by project works (the B zone), and 2,700 acres subject to flooding by backwater of the White River are in the C zone which would not benefit from drainage.

This area is typical of the alluvial area of eastern Arkansas. General farming predominates; cotton, rice, soybeans, and livestock-feed production are the major enterprises. The area as a whole is poorly developed, with only about 30 percent of the land in farm units of more than 280 acres. About 61 percent is open land, 38 percent is woodland, and 1 percent is urban area or is watered.

About 7 percent of the area is composed of very slowly permeable poorly drained clay soils of the Mississippi River bottom land, all of which lie in the area of frequent backwater flooding. Poorly drained silt loams of the Mississippi River bottom land constitute about 18 percent of the area. These soils are presently poorly developed for agricultural production but have a high agricultural potential when drained.

Sandy and silt loams predominate on about 43 percent. They are underlain at varying depths with heavy clays of alluvial origin. These soils

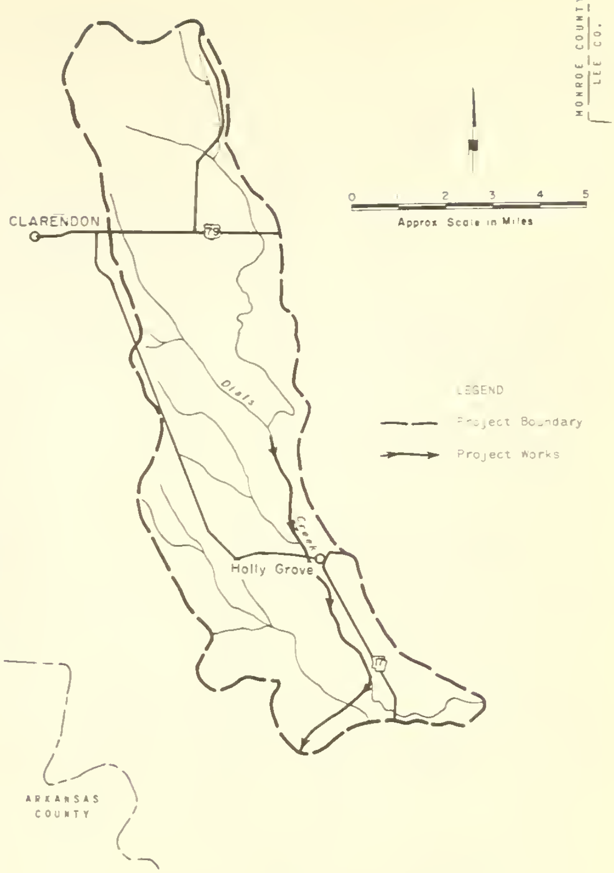


Figure 22.--Project area location, Dials Creek Basin, Arkansas.

are particularly adapted to rice culture. The remaining 32 percent is composed of sandy loam and silt loam soils. These well-drained soils are highly developed agriculturally and are very productive.

USDA estimated that if the area were adequately protected from flooding and overflow and if adequate drainage were provided, 92 percent of all land in the A zone, 88 percent of all land in the B zone, and 4 percent of all land in the C zone would be open land. The changes in major land use and in the percentage of land drained, by soil units, expected to occur with project development, under assumptions of adequate flood protection and drainage, are shown in table 32.

As shown in tables 33 and 34, net annual agricultural income in the Dials Creek Basin is expected to increase 60 percent and total agricultural production 50 percent with project development.

With proposed project construction, it is anticipated that 4,500 acres of woodland of 5,400 acres converted, would be drained and 6,300 acres of farmland would be drained, making a total of 10,800 acres of farmland drained with the project. The total associated cost of land

TABLE 32.--Dials Creek Basin: Major land use and drainage, present and estimated future without and with project, soil units and zones

Item	All land in zone			Percentage of zone in--						Percentage of open land drained[1]		
				Open land			Woodland					
	A	B	C	A	B	C	A	B	C	A	B	C
	100 acres	*100 acres*	*100 acres*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*
Soil unit 1:												
Present.................			27			2			98			0
Without project.........			27			4			96			0
With project............			27			4			96			0
Soil unit 4:												
Present.................	91	3		68	48		32	52		0	0	
Without project.........	91	3		73	51		27	49		2	0	
With project............	91	3		93	63		7	37		80	75	
Soil unit 6:												
Present.................	31	12		50	12		50	88		0	0	
Without project.........	31	12		53	17		47	83		0	0	
With project............	31	12		88	83		12	17		74	70	
Soil unit 10:												
Present.................	33			31			69			0		
Without project.........	33			45			55			0		
With project............	33			89			11			80		
Soil unit 11:												
Present.................	89	13		92	87		8	13		100	100	
Without project.........	89	13		92	87		8	13		100	100	
With project............	89	13		92	99		8	1		100	100	
All:												
Present.................	244	28	27	70	50	2	30	50	98	50	78	0
Without project.........	244	28	27	74	53	4	26	47	96	48	75	0
With project............	244	28	27	92	88	4	8	12	96	86	86	0

[1] Includes naturally and artificially drained land.

TABLE 33.--Dials Creek Basin: Estimated effects of project development on cropping systems[1]

Crop	Percentage change in acreage			Percentage change in production			Percentage change in net return		
	A zone	B zone	All land	A zone	B zone	All land	A zone	B zone	All land
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Cotton....................	20	46	22	51	57	52	78	122	83
Corn......................	-2	16	-1	27	30	27	5	15	5
Rice......................	93	462	107	138	519	155	286	670	407
Soybeans..................	30	81	34	34	73	36	30	72	32
Oats......................	34	84	37	60	73	63	57	80	58
Oats pasture..............	34	109	38	67	93	68	72	137	75
Grain sorghum.............	28	400	41	40	478	55	35	515	53
Permanent pasture.........	23	63	26	68	88	70	110	178	114
Idle......................	11	68	14						
Other.....................	25	66	28						
Woodland..................	-68	-74	-52	-68	-74	-52	-64	-74	-57
All land..............	0	0	0	50	60	50	57	94	60

[1] No change in acreage, production, or net return in C zone. "All land" includes C zone.

TABLE 34.--Dials Creek Basin: Estimated future crop acreages, crop production, and net return without and with project development

Crop	Without project			With project			Difference in net return	Percentage increase in net return
	Acres	Production[1]	Net return	Acres	Production[1]	Net return		
	100 acres	*1,000 units*	*1,000 dollars*	*100 acres*	*1,000 units*	*1,000 dollars*	*1,000 dollors*	*Percent*
Cotton..............	85	8	161	103	12	294	133	83
Corn................	11	50	30	11	64	32	2	7
Rice................	6	18	6	14	46	24	18	300
Soybeans............	26	69	76	35	49	101	25	33
Oats................	22	80	23	30	130	36	13	57
Oats pasture........	[2] (14)	169	17	(20)	284	29	12	71
Grain sorghum.......	2	4	2	3	7	4	2	100
Permanent pasture....	13	334	16	17	566	35	19	119
Idle................	11			12				
Other...............	20			25				
Woodland............	103		25	49		14	-11	-44
Total...........	299		356	299		569	213	60

[1] Cotton--500-pound bales; corn soybeans, oats, and grain sorghum--bushels; rice--hundredweights; beef--pounds. [2] Duplicated acreage.

development was estimated by USDA at $392,300, with the annual equivalent (including annual drainage maintenance cost) at $77,200.

As indicated in table 35, the annual increase in net agricultural income was estimated at $212,700. The discounted values of annual increase in net agricultural income and of annual equivalent associated costs were estimated at $132,100 and $53,600, respectively.

TABLE 35.--Dials Creek Basin: Project summary

Item	Amount
Drainage operations:	*Acres*
Woodland converted to open cropland	5,400
Farmland drained..................	10,800
Associated costs:	
Initial:	*Dollars*
Woodland conversion...............	31,000
Farm drainage installation........	135,600
Group drainage installations......	225,700
Total associated costs...........	392,300
Annual equivalent:	
Conversion......................	17,000
Farm drainage....................	17,600
Group drainage....................	27,200
Annual farm drainage maintenance...	15,400
Total annual costs..............	77,200
Annual increase in net farm income..	212,700
Discounted value of:	
Annual increase in net farm income	132,000
Annual associated costs..........	54,000
Unadjusted benefits............	78,000

L'Anguille River Basin

The project proposed for the L'Anguille River Basin (fig. 23) consists of channel cleanout, enlargement, and realignment of the L'Anguille

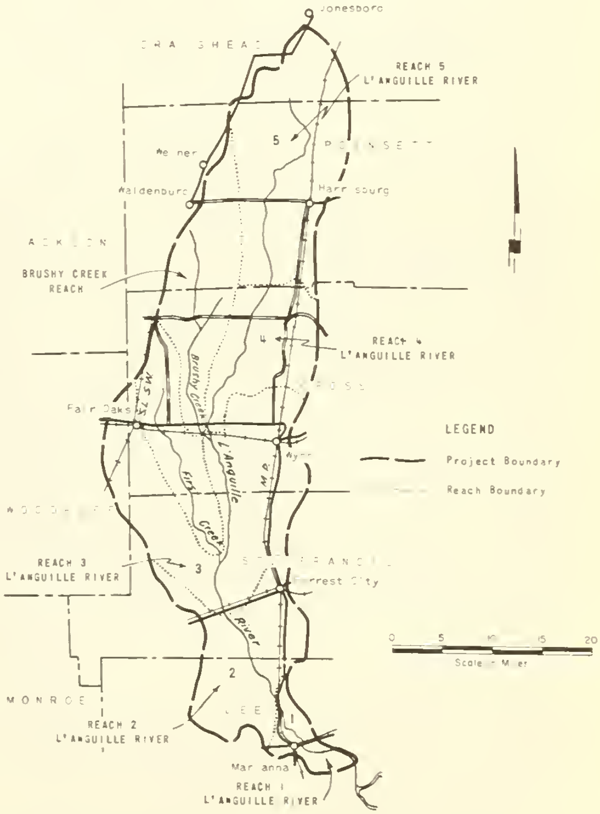


Figure 23.--Project area location, L'Anguille River Basin, Arkansas.

River and two major tributaries, Brushy and First Creeks. When constructed, the project would serve as a major outlet for farm and group drainage systems for about 593,700 acres. Lying above the contour of the flood of record and free from flooding are 488,500 acres; 88,800 acres are affected by flooding that could be alleviated by construction of project works; and 16,400 acres are subject to flooding of such frequency as to preclude any further agricultural development. The latter area would not benefit from project drainage.

The area is typical of the mixed alluvial-loess terrace area of eastern Arkansas. General farming predominates; cotton, rice, soybeans, and feed crops are the major enterprises. Most of the area is now in small farms of 280 acres or less.

Bottom-land soils are of relatively minor importance. They comprise only about 8 percent of the area. Soils of the loess terrace constitute about 79 percent and occur mainly in the zone that is free from flooding. The rest of the area, about 13 percent, is composed of soils of Crowley's Ridge.

About 62 percent is open land, 37 percent is wooded, and 1 percent is urban area or is watered. Most of the woods occur on the poorer drained heavy soils in the area.

USDA estimated that with adequate flood pro-

TABLE 36.--L'Anguille River Basin: Major land use and drainage, present and estimated future without and with project soil units and zones

Item	All land in zone			Percentage of zone in--						Percentage of open land drained[1]		
				Open land			Woodland					
	A	B	C	A	B	C	A	B	C	A	B	C
	100 acres	*100 acres*	*100 acres*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Soil unit 1:												
Present		14	47		45	23		55	77		0	0
Without project		14	47		45	30		55	70		10	0
With project		14	47		72	30		28	70		13	0
Soil unit 4:												
Present		35	25		33	2		67	98		0	0
Without project		35	25		37	11		63	89		12	0
With project		35	25		82	11		18	89		65	0
Soil unit 6:												
Present		140	86		7	8		93	92		7	0
Without project		140	86		13	23		87	77		7	0
With project		140	86		64	23		36	77		62	0
Soil unit 7:												
Present	6			58			42			8	3	
Without project	6			63			37			22	3	
With project	6			66			34			60	68	
Soil unit 8:												
Present	70	96		32	29		68	66		2		
Without project	70	96		36	34		64	34		7		
With project	70	96		62	66		38	33		73		
Soil unit 9:												
Present	1,866	144	6	78	67	49	22	33	51	43	92	0
Without project	1,866	144	6	78	69	57	22	31	43	50	92	0
With project	1,866	144	6	85	87	57	15	13	43	89	98	0
Soil unit 10:												
Present	2,454	459		63	63		37	37		13	6	
Without project	2,454	459		69	67		31	33		30	19	
With project	2,454	459		89	85		11	15		85	76	
Soil unit 15:												
Present	489			52			48			100		
Without project	489			52			48			100		
With project	489			52			48			100		
All:												
Present	4,885	888	164	67	50	13	33	50	87	33	24	0
Without project	4,885	888	164	70	54	24	30	46	76	44	33	0
With project	4,885	888	164	83	80	24	17	20	76	87	76	0

[1] Includes naturally and artificially drained land.

tection and drainage, 83 percent of all land in the A zone, 80 percent of all land in the B zone, and 24 percent of all land in the C zone would be open land. The changes in major land use and in percentage of land drained, by soil units, expected to occur with the project, under assumptions of adequate flood protection and drainage, are indicated in table 36.

As shown in tables 37 and 38, net annual agricultural income and total agricultural production are each expected to increase 43 percent with project development.

It is expected that with adequate flood protection and drainage 73,800 acres of woodland of 86,900 acres converted would be drained with the project. A total of 217,300 acres of farmland

TABLE 37.--L'Anguille River Basin: Estimated effects of project development on cropping systems[1]

Crop	Percentage change in acreage			Percentage change in production			Percentage change in net return		
	A zone	B zone	All land	A zone	B zone	All land	A zone	B zone	All land
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Cotton...........	16	56	19	45	99	50	32	122	39
Corn.............	17	110	33	31	182	55	32	204	55
Rice.............	25	46	27	50	76	54	122	193	129
Soybeans.........	19	40	22	31	69	36	33	86	40
Oats.............	14	40	16	36	73	40	49	98	53
Oats pasture.....	20	52	23	37	81	41	31	74	35
Grain sorghum....	23	174	29	23	168	29	19	165	27
Permanent pasture	19	38	22	45	81	49	42	85	47
Idle.............	18	37							
Other............	19	48							
Woodland.........	-44	-56	-43	-44	-44	-43	-35	-56	-36
All land....	0	0	0	40	73	43	38	80	43

[1] No change in acreage, production, or net return in C zone. "All land" includes C zone.

TABLE 38.--L'Anguille River Basin: Estimated future crop acreages, crop production, and net return without and with project development

Crop	Without project			With project			Difference in net return	Percentage increase in net return
	Acres	Production[1]	Net return	Acres	Production[1]	Net return		
	100 acres	*1,000 units*	*1,000 dollars*	*100 acres*	*1,000 units*	*1,000 dollars*	*1,000 dollars*	*Percent*
Cotton...............	986	74	1,448	1,174	110	2,018	570	39
Corn.................	113	350	204	149	540	317	113	55
Rice.................	718	1,984	696	916	3,046	1,594	898	129
Soybeans.............	714	1,278	1,207	871	1,741	1,692	485	40
Oats.................	393	1,148	288	457	1,603	441	153	53
Oats pasture.........	[2] (263)	2,386	279	(325)	3,363	376	97	35
Grain sorghum........	72	139	78	93	179	99	21	27
Permanent pasture....	330	8,992	562	401	13,369	824	262	47
Idle.................	236			283				
Other................	396			483				
Woodland.............	1,979		727	1,110		462	-265	-36
Total...........	5,937		5,489	5,937		7,823	2,334	43

[1] Cotton--500-pound bales; corn, soybeans, oats, and grain sorghum--bushels; rice--hundredweights; beef--pounds.
[2] Duplicated acreage.

(including the converted woodland) is anticipated to be drained. The total associated cost of land development was estimated by USDA at $11,644,800, with the annual equivalent at $1,307,000, including $247,000 for annual drainage maintenance.

As shown in table 39, the annual increase in net agricultural income was estimated at $2,334,000. The discounted values of annual increase in net agricultural income and of annual equivalent associated costs are estimated at $1,292,600 and $808,700, respectively.

TABLE 39.--L'Anguille River Basin: Project summary

Item	Amount
Drainage operations:	
Woodland converted to open cropland	*Acres* 86,900
Farmland drained	217,300
Associated costs:	
Initial:	*Dollars*
Woodland conversion	5,446,200
Farm drainage installations	2,552,800
Group drainage installations	3,645,800
Total associated costs	11,644,800
Annual equivalent:	
Conversion	298,300
Farm drainage	330,600
Group drainage	431,100
Annual farm drainage maintenance	247,000
Total annual costs	1,307,000
Annual increase in net farm income	2,334,000
Discounted value of:	
Annual increase in net farm income	1,293,000
Annual associated costs	809,000
Unadjusted benefits	484,000

St. Francis River Basin

The St. Francis River and tributaries project (Ark., fig. 24) consists of cleanout, enlargement, and realignment for 17 St. Francis River tributaries with outlets in Arkansas, except in the Pettyville subarea, where the proposed improvement consists of a pumping station. No Federal construction has been done in any of the subareas except on Tyronza River, where the channel was improved during 1939 and 1940 from mile 15 upstream to a point about 1.2 miles above U.S. Highway 63. Improvement included a cutoff.

The purpose of the project is to furnish major outlets to serve agricultural drainage within the drainage areas of the St. Francis River tributaries. The proposed facilities are designed to serve 1,237,000 acres, 1,011,000 of which lie above the contour of the flood of record and are thus free from floods; 222,800 acres are affected by flooding that could be alleviated through construction of the proposed project works; and 3,200 acres occupy a permanently wet sump area that would not benefit.

The area is typical of the farming area of eastern Arkansas and southeastern Missouri, so far as soils and cropping systems are concerned. General farming predominates; cotton, rice, soybeans and livestock-feed are grown, with crop production the major enterprise. The area as a whole differs markedly from the rest of the eastern Arkansas alluvial area in that it has attained a fairly high level of development. It was estimated that from 80 to 90 percent of the land area is in farms of more than 280 acres each.

The soils in the St. Francis River Basin in Arkansas are mainly alluvium from the Mississippi River and its tributaries. A minor part of the project contains soils of the loess terrace, and about 5 percent contains soils of Crowley's Ridge.

About 13 percent of the area is comprised of sandy loam and loamy sand soils. Normally, these soils are well drained and need no drainage improvements. They are well developed agriculturally and with good management moderately high yields are obtained in average years. During dry years, however, yields are drastically reduced because of the low water-holding capacity of these soils.

Coarse-textured, poorly drained soils comprise about 5 percent. These soils are underlain with heavy clays of alluvial origin; the clays inhibit internal drainage and adversely affect plant growth during wet seasons. The soils are inherently productive, however, and high yields can be obtained with adequate drainage. Sandy and silt loams predominate on about 28 percent. Soils in this soil association group yield the highest production levels in the area when drained and properly managed. Less than 1 percent is comprised of medium-textured, poorly drained bottom-land soils which require intensive drainage.

About 8 percent of the area is composed of poorly drained clay soils intermingled with excessively drained sandy soils. These soils are moderately well developed and yields are moderately high. Because of flat topography, low elevations, and slow permeability of the clays, surface flooding and waterlogging tend to prevail during the early part of the growing season unless artificial drainage is provided. These soils are inherently productive and high yields of adapted crops can be obtained regularly under good management when surface water accumulations are rapidly removed.

About 41 percent of the area is composed of poorly and somewhat poorly drained clay soils. They are moderately well developed agriculturally and although yields are moderate, they respond well to drainage improvement. These soils are flooded and waterlogged several times during each cropping season. They are inherently productive, and excellent yields of

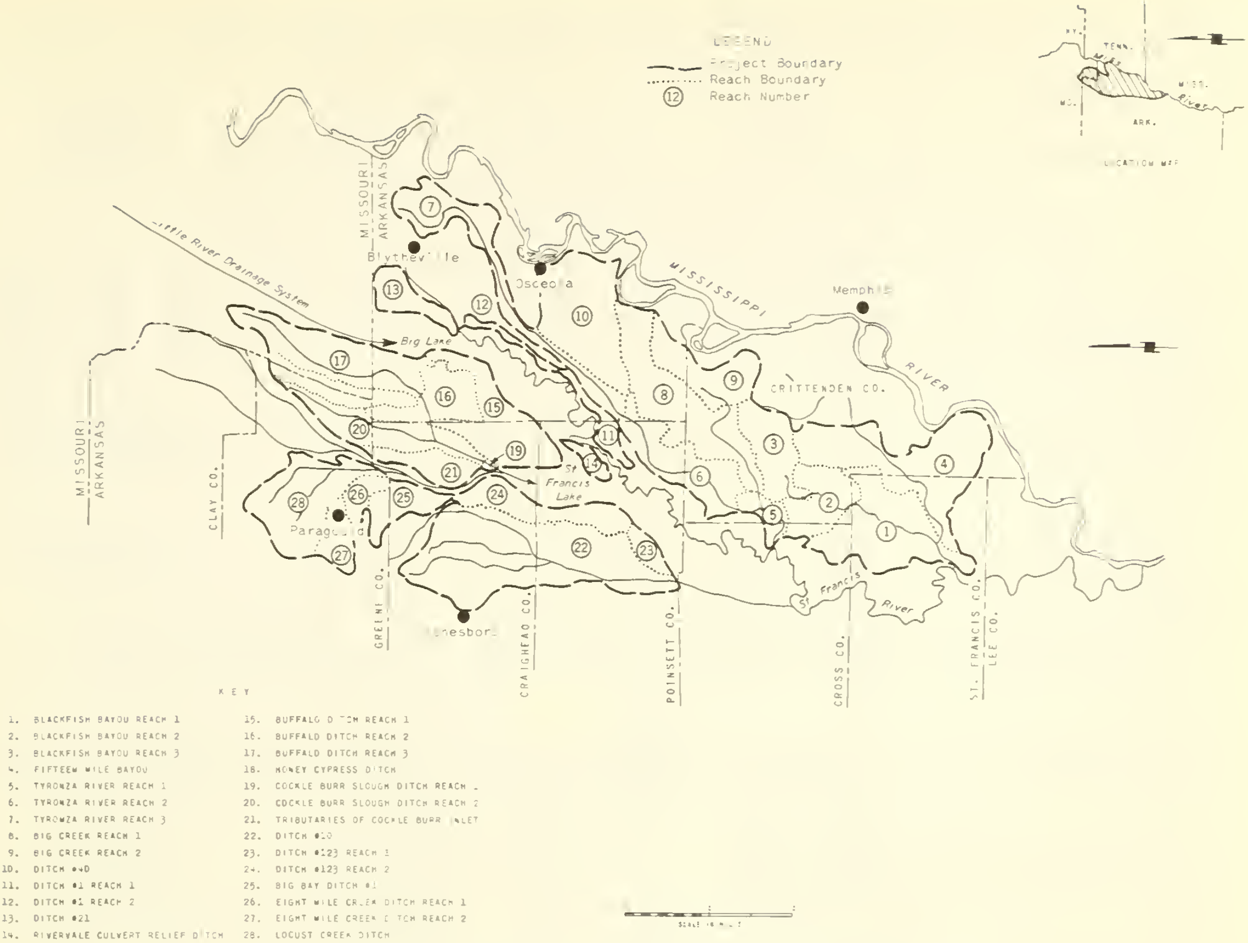


Figure 24.--Project area location, St. Francis River and Tributaries, Arkansas.

adapted crops can be regularly obtained when surface water accumulations are rapidly removed.

About 89 percent of the area, exclusive of Crowley's Ridge is open land; about 10 percent is wooded, and there are negligible amounts of urban and watered areas. Most of the woods are on the heavier, poorly drained soils.

USDA estimated that if adequate flood protection and drainage were provided, 97 percent of all land in the A zone, 96 percent of all land in the B zone, and 91 percent of all land in the C zone would be open land. The changes in major land use and in the percentage of open land drained, by soil units, expected to occur with project development under assumptions of adequate flood protection and drainage, are shown in table 40.

As indicated in tables 41 and 42, net annual agricultural income in the area is expected to increase 15 percent and total agricultural production 16 percent with project development.

If the proposed flood control-drainage project were installed, it is anticipated that of 41,000 acres of woodland converted, 37,300 acres would be drained. A total of 302,000 acres of farmland (including the converted woodland) is expected to be drained with the project. The total associated costs of land development in the St. Francis River Basin were estimated at $7,585,200, with the annual equivalent at $1,116,900, of which $495,800 is drainage maintenance.

As shown in table 43, the annual increase in net agricultural income was estimated at $3,268,000. The discounted values of annual increase in net agricultural income and of annual equivalent associated costs were estimated at $2,199,000 and $761,000, respectively.

TABLE 40.--St. Francis River Basin: Major land use and drainage, present and estimated future without and with project, soil units and zones

Item	All land in zone			Percentage of zone in--						Percentage of open land drained[1]		
				Open land			Woodland					
	A	B	C	A	B	C	A	B	C	A	B	C
	100 acres	*100 acres*	*100 acres*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Soil unit 1:												
Present	1,710	758	13	82	75	92	18	25	8	12	10	0
Without project	1,710	758	13	93	81	92	7	19	8	76	68	0
With project	1,710	758	13	98	94	92	2	6	8	97	92	0
Soil unit 2:												
Present	2,166	377	17	93	68	91	7	32	9	12	14	0
Without project	2,166	377	17	98	78	91	2	22	9	78	75	0
With project	2,166	377	17	100	96	91	0	4	9	97	92	0
Soil unit 3:												
Present	882	94		99	94		1	6		1	6	
Without project	882	94		99	97		1	3		67	43	
With project	882	94		99	97		1	3		93	85	
Soil unit 4:												
Present	1,672	880	2	95	92	72	5	8	28	8	7	
Without project	1,672	880	2	97	95	86	3	5	14	50	42	
With project	1,672	880	2	99	98	86	1	2	14	91	86	
Soil unit 6:												
Present	50			17			83			2		
Without project	50			85			15			47		
With project	50			93			7			89		
Soil unit 7:												
Present	215	21		83	91		17	9		2	13	
Without project	215	21		87	93		13	7		39	38	
With project	215	21		95	96		5	4		84	80	
Soil unit 9:												
Present	32			88			12			1		
Without project	32			95			5			35		
With project	32			98			2			85		
Soil unit 10:												
Present	562			82			18			7		
Without project	562			87			13			36		
With project	562			96			4			85		
Soil unit 11:												
Present	608	19		99	97		1	3		100	100	
Without project	608	19		99	99		1	1		100	100	
With project	608	19		99	99		1	1		100	100	
Soil unit 12:												
Present	940	55		99	98		1	2		100	100	
Without project	940	55		99	99		1	1		100	100	
With project	940	55		99	99		1	1		100	100	
Soil unit 15:												
Present	636			67			33			100		
Without project	636			67			33			100		
With project	636			67			33			100		
Soil unit 16:												
Present	637	24		99	96		1	4		1	0	
Without project	637	24		99	96		1	4		30	20	
With project	637	24		99	96		1	4		85	82	
All:												
Present	10,110	2,228	32	91	83	91	9	17	9	28	13	0
Without project	10,110	2,228	32	95	88	91	5	12	9	70	57	
With project	10,110	2,228	32	97	96	91	3	4	9	94	89	

[1] Includes naturally and artificially drained land.

TABLE 41.--St. Francis River Basin: Estimated effects of project development on cropping systems[1]

Crop	Percentage change in acreage			Percentage change in production			Percentage change in net return		
	A zone	B zone	All land	A zone	B zone	All land	A zone	B zone	All land
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Cotton............	4	25	7	15	45	20	18	50	24
Corn..............	2	11	2	10	27	12	11	26	12
Rice..............	-6	11	-3		13	3	11	16	12
Soybeans..........	2	2	2	6	4	5	6	4	6
Oats..............	2		1	14	15	14	19	18	19
Oats pasture......	9	5	8	19	21	19	17	18	17
Grain sorghum.....	-1	5	1		9	2		10	3
Permanent pasture.	2	-1	1	19	17	19	22	21	22
Idle..............	0	-48	-13						
Other.............	2	10	4						
Woodland..........	-40	-69	-50	-40	-69	-52	-35	-69	-48
All land......	0	0	0	12	33	16	13	26	15

[1] No change in acreage, production, or net return in C zone. "All land" includes C zone.

TABLE 42.--St. Francis River Basin: Estimated future crop acreages, crop production, and net return without and with project development

Crop	Without project			With project			Difference in net return	Percentage increase in net return
	Acres	Production[1]	Net return	Acres	Production[1]	Net return		
	100 acres	*1,000 units*	*1,000 dollars*	*100 acres*	*1,000 units*	*1,000 dollars*	*1,000 dollars*	*Percent*
Cotton..............	4,935	451	9,786	5,294	543	12,115	2,329	24
Corn................	594	2,570	1,545	609	2,877	1,733	188	12
Rice................	441	1,446	741	430	1,482	828	87	12
Soybeans............	2,386	5,956	6,624	2,439	6,266	7,025	401	6
Oats................	823	3,072	854	835	3,513	1,015	161	19
Oats pasture.........	[2] (231)	2,422	275	(250)	2,882	321	46	17
Grain sorghum........	275	657	415	276	671	425	10	2
Permanent pasture....	428	11,879	745	433	14,104	906	161	22
Idle.................	507			442				
Other................	1,156			1,197				
Woodland.............	825		240	415		125	-115	-48
Total...........	12,370		21,225	12,370		24,493	3,268	15

[1] Cotton--500-pound bales; corn, soybeans, oats, and grain sorghum--bushels; rich--hundredweights; beef--pounds.
[2] Duplicated acreage.

TABLE 43.--St. Francis River Basin, Arkansas: Project summary

Item	Amount
Drainage operations:	
Woodland converted to open cropland	*Acres* 41,000
Farmland drained	302,000
Associated costs:	
Initial:	*Dollars*
Woodland conversion	2,678,200
Farm drainage installations	4,311,300
Group drainage installations	595,700
Total associated costs	7,585,200
Annual equivalent:	
Conversion	146,700
Farm drainage	415,300
Group drainage	59,100
Annual farm drainage maintenance	495,800
Total annual costs	1,116,900
Annual increase in net farm income	3,268,000
Discounted value of:	
Annual increase in net farm income	2,199,000
Annual associated costs	761,000
Unadjusted benefits	1,438,000

Lower Mississippi River and Tributaries Project in Arkansas

The purpose of proposed flood-control-drainage projects in Arkansas is to furnish major drainage outlets for agriculture within specified drainage areas in the lower Mississippi River Basin and to protect these areas from flooding and overflow. The proposed facilities are designed to serve 4,561,600 acres; 3,320,700 acres of which lie above the contour of the flood of record. These lands are not subject to overflow but require drainage for their most efficient use. In the project area in Arkansas are 1,112,200 acres subject to flooding in some degree. These lands, which lie between the contour of the flood of record and the permanently wet low areas, would benefit from both drainage and flood control provided by the proposed project works. Lying within the undrained sump areas are 128,700 acres that would not benefit.

USDA estimated that if adequate flood protection and drainage were provided, 91 percent of all land in the A zone, 85 percent of all land in the B zone, and 16 percent of all land in the C zone within the project area in the State would be open land; that with project development, assuming adequate flood protection, 87 percent of all open land in the A zone and 81 percent of all open land in the B zone would have adequate drainage and would participate in the drainage project. The changes in major land use and in the percentage of open land drained, by soil units, expected to occur with project development under assumptions of adequate flood protection are shown in table 44.

As shown in tables 45 and 46 with project development in Arkansas, net annual agricultural income in the affected areas is expected to increase 40 percent and total agricultural production 46 percent.

If the proposed flood-control-drainage project were installed, it was estimated that 690,000 acres of woodland would be converted to open cropland. A total of 1,602,000 acres of farmland (including the converted woodland) would be drained. The total land-development cost associated with project development--the cost of converting woodland, and the cost of farm and group drainage systems--was estimated by USDA at $81,449,000, the annual equivalent cost of which was estimated at $9,465,200 including annual farm drainage maintenance.

As shown in table 47, the annual increase in net agricultural income attributable to the proposed project in Arkansas was estimated by USDA at $19,933,000 annually. The discounted values of annual increase in net agricultural income and of annual equivalent associated costs attributable to the proposed project were estimated by USDA at $11,556,000 and $5,916,000, respectively.

TABLE 44.--All projects in Arkansas: Major land use and drainage, present and estimated future without and with project, soil units and zones

Item	All land in zone			Percentage of zone in--						Percentage of open land drained[1]		
				Open land			Woodland					
	A	B	C	A	B	C	A	B	C	A	B	C
	100 acres	100 acres	100 acres	Per-cent	Per-cent	Per-cent	Per-cent	Per-cent	Per-cent	Per-cent	Per-cent	Per-cent
Soil unit 1:												
Present	2,650	2,808	896	75	45	9	25	55	91	11	8	0
Without project	2,650	2,808	896	85	55	13	15	45	87	59	32	0
With project	2,650	2,808	896	95	83	13	5	17	87	90	80	0
Soil unit 2:												
Present	2,513	554	32	92	67	53	8	33	47	12	13	0
Without project	2,513	554	32	97	74	53	3	26	47	70	58	0
With project	2,513	554	32	99	94	53	1	6	47	95	89	0
Soil unit 3:												
Present	882	94		99	94		1	6		1	6	
Without project	882	94		99	97		1	3		67	43	
With project	882	94		99	97		1	3		95	85	
Soil unit 4:												
Present	3,952	1,962	69	87	75	32	13	25	68	7	9	0
Without project	3,952	1,962	69	90	78	38	10	22	62	33	32	0
With project	3,952	1,962	69	97	94	38	3	6	62	86	82	0
Soil unit 6:												
Present	1,252	2,291	266	40	24	6	60	26	94	8	14	0
Without project	1,252	2,291	266	44	26	17	56	24	83	19	18	0
With project	1,252	2,291	266	86	80	17	14	20	83	76	78	0
Soil unit 7:												
Present	646	82		84	54		16	46		5	5	
Without project	646	82		88	56		12	44		24	18	
With project	646	82		96	89		4	11		70	71	
Soil unit 8:												
Present	504	524		52	28		48	74		1	6	
Without project	504	524		56	30		44	70		9	10	
With project	504	524		83	72		17	28		75	72	
Soil unit 9:												
Present	5,892	553	8	80	60	43	20	40	57	45	71	0
Without project	5,892	553	8	84	63	43	16	37	57	53	74	0
With project	5,892	553	8	92	86	43	8	14	57	87	93	0
Soil unit 10:												
Present	8,804	1,999		67	46		33	54		10	13	
Without project	8,804	1,999		72	54		28	36		25	23	
With project	8,804	1,999		92	84		8	16		81	78	
Soil unit 11:												
Present	1,766	176	16	92	85	6	8	15	94	100	100	0
Without project	1,766	176	16	95	86	18	5	14	82	100	100	0
With project	1,766	176	16	95	94	18	5	6	82	100	100	0
Soil unit 12:												
Present	964	55		99	98		1	2		100	100	
Without project	964	55		99	100		1	0		100	100	
With project	964	55		99	100		1	0		100	100	
Soil unit 15:												
Present	2,745			58			42			100		
Without project	2,745			60			40			100		
With project	2,745			60			40			100		
Soil unit 16:												
Present	637	24		99	96		1	4		1	0	
Without project	637	24		99	96		1	4		30	22	
With project	637	24		99	96		1	4		85	78	
All:												
Present	33,207	11,122	1,287	76	49	11	24	51	89	30	17	0
Without project	33,207	11,122	1,287	80	54	16	20	46	84	51	35	0
With project	33,207	11,122	1,287	91	85	16	9	15	84	87	81	0

[1] Includes naturally and artificially drained land.

TABLE 45.--All projects in Arkansas: Estimated effects of project development on cropping systems[1]

Crop	Percentage change in acreage			Percentage change in production			Percentage change in net return		
	A zone	B zone	All land	A zone	B zone	All land	A zone	B zone	All land
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Cotton	15	77	25	34	130	55	42	141	58
Corn	3	49	10	17	86	27	18	92	28
Rice	23	75	35	40	105	57	88	146	101
Soybeans	11	59	21	16	72	29	19	76	30
Oats	12	38	16	31	63	37	42	75	45
Oats pasture	17	69	25	38	90	48	33	87	41
Grain sorghum	16	31	18	51	33	44	14	34	17
Permanent pasture	10	48	17	36	96	50	40	106	51
Idle	7	-11	2						
Other	13	57	21						
Woodland	-55	-67	-55	-54	-61	-50	-41	-70	-51
All land	0	0	0	35	94	46	32	76	40

[1] No change in acreage, production, or net return in C zone. "All land" includes C zone.

TABLE 46.--All projects in Arkansas: Estimated future crop acreages, crop production, and net return without and with project development

Crop	Without project			With project			Difference in net return	Percentage increase in net return
	Acres	Production[1]	Net return	Acres	Production[1]	Net return		
	100 acres	*1,000 units*	*1,000 dollars*	*100 acres*	*1,000 units*	*1,000 dollars*	*1,000 dollars*	*Percent*
Cotton	11,768	961	18,903	14,714	1,485	29,806	10,903	58
Corn	1,535	5,608	3,256	1,685	7,132	4,171	915	28
Rice	3,151	9,173	3,687	4,243	14,401	7,428	3,741	101
Soybeans	6,000	12,771	13,259	7,234	16,416	17,196	3,937	30
Oats	2,291	7,180	1,829	2,661	9,846	2,659	830	45
Oats pasture	[2] (1,166)	10,693	1,235	(1,454)	15,831	1,736	501	41
Grain sorghum	616	1,324	798	727	1,912	936	138	17
Permanent pasture	2,144	52,131	3,159	2,502	78,017	4,768	1,609	51
Idle	2,156			2,199				
Other	3,288			3,988				
Woodland	12,667		4,269	5,663		2,084	-2,185	-51
Total	45,616		50,395	45,616		70,784	20,389	40

[1] Cotton--500-pound bales; corn, soybeans, oats, and grain sorghum--bushels; rice--hundredweights; beef--pounds.
[2] Duplicated acreage.

TABLE 47.--Mississippi River and Tributaries Project Area in Arkansas: Project summary

Item	Amount	Item	Amount
Drainage operations:		Associated costs--Continued	
Woodland converted to open	*Acres*	Annual equivalent:	*Dollars*
cropland	690,000	Conversion	2,261,000
Farmland drained	1,602,000	Farm drainage	2,572,000
		Group drainage	2,349,000
		Annual farm drainage maintenance	2,283,000
Associated costs:		Total annual costs	9,465,000
Initial:	*Dollars*	Annual increase in net farm income	19,932,000
Woodland conversion	40,669,000	Discounted value of:	
Farm drainage installations	20,968,000	Annual increase in net farm income	11,556,000
Group drainage installations	19,812,000	Annual associated costs	5,916,000
Total associated costs	81,449,000	Unadjusted benefits	5,640,000

HILL-LAND PROBLEM AREAS IN ARKANSAS

Crowley's Ridge

There are about 443,000 acres in Crowley's Ridge in Arkansas. The ridge is divided into three natural segments: The southern segment between Helena and Marianna, the central segment from Marianna to a point 7 miles south of Jonesboro, and the northern segment from a point 7 miles south of Jonesboro to the Missouri line.

The southern segment contains 36,800 acres, of which 12 percent is land-capability class I and II land and 88 percent is land-capability class III to VII land.[23] About 15 percent of the area is cultivated, 10 percent is in pasture, and 75 percent is woodland.

The central segment contains 131,600 acres, of which 19 percent is land-capability class I and II land, and 81 percent is land-capability class III to VII land. About 35 percent is cultivated, 20 percent is in pasture, and 45 percent is woodland.

The northern segment contains 274,600 acres, of which 33 percent is land-capability class I and II land, and 67 percent is land-capability class III to VII land. About 40 percent of the area is cultivated; 25 percent is in pasture; and 35 percent is woodland.

The soils on the ridge are predominately loessial fine silt loams. Beds of rounded gravel occur in several localities near the base of the ridge. Erosion rates range from moderate to very severe. Gullies 10 to 40 feet deep are common, even in the wooded areas. Spectacular erosion occurs in many abandoned fields and poor pastures. These actively eroding critical areas have an estimated rate of gross erosion of 0.2 to 0.25 acre-foot per acre per year. Streambank erosion is a minor source of sediment because the well-developed channels within the ridge area are short.

Sediment carried from the ridge is delivered into interceptor and drainage channels where it causes sandbars and channel aggradation. This condition reduces the capacity of the channels to carry runoff from the ridge and increases tremendously the maintenance cost on the channels.

[23] Definition of land-capability classes:

Suitable for regular cultivation:
- Class I: Very good land; few or no limitations; can be cultivated with ordinary good farming methods.
- Class II: Good land; moderate limitations or hazards; can be cultivated safely with moderately intensive treatments.
- Class III: Moderately good land; severe limitations or hazards; can be cultivated safely with intensive treatments.

Suitable for limited cultivation:
- Class IV: Fairly good land; very severe limitations or hazards; suited to some forms of limited cultivation or for limited choice of crops but usually best suited to pasture or hay.

Not suitable for cultivation but suited to grazing or forestry:
- Class V: Not more than slight limitations.
- Class VI: Moderate limitations.
- Class VII: Severe limitations.

Cairo Drainage District--Mounds and Mound City Area Project

This project (fig. 25) consists of the Cache River pumping plant and Cairo Drainage District pumping plant. The Cache River pumping plant would be located in the extreme southeastern corner of Pulaski County, Ill., and the Cairo Drainage District pumping plant in the extreme northeastern corner of Alexander County.

Ditches would be provided to divert the runoff from Mounds Creek to the Cache River pumping plant and from Goose Pond to the Cairo Drainage District pumping plant, respectively. The pumping plants and diversion ditches are intended to reduce the extent of flooding of the project area and to provide major drainage outlets. The project is designed to serve as major outlets for farm drainage systems for 13,200 acres.

The Mounds Creek subarea is entirely agricultural with no urban areas included, and benefits accruing from the proposed project would come almost entirely from the provision of adequate outlets for farm drainage and from flood abatement. The Cache River and Cottonwood Slough subareas are chiefly agricultural with 6 and 4 percent, respectively, of the total subarea in urban use. About 50 percent of the Goose Pond subarea is in urban use.

On the land used for farming in the subareas, general farming predominates. Corn, cotton, soybeans, small grain, hay, and pasture are the principal crops.

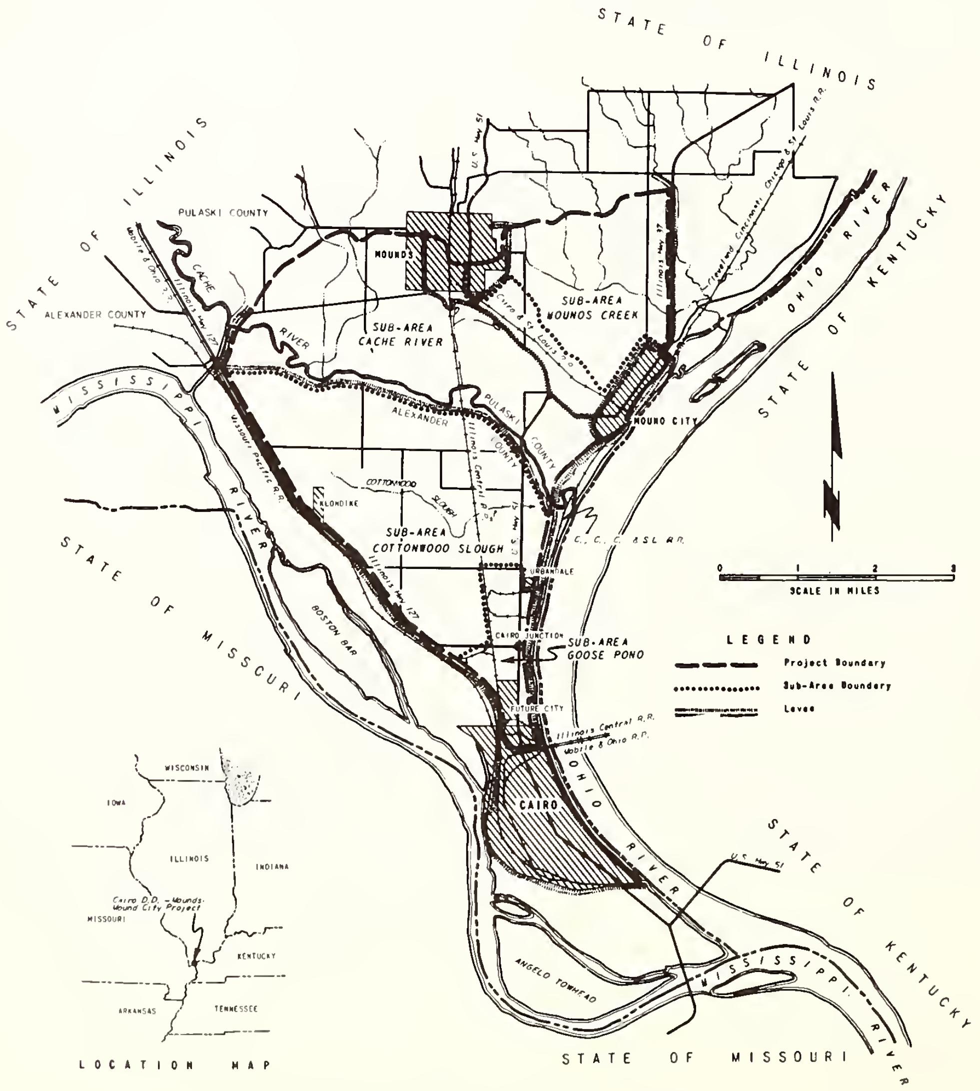


Figure 25.--Cairo D. D.--Mounds-Mound City Project, Illinois.

The soils of the project area are poorly drained; they range from medium silts to fine clays. About 13 percent of the area consists of dark-colored soils, with fine textures from the surface throughout. They are very poorly drained and difficult to till but are very productive when adequately drained. These soils usually occur in the lower lying or depressional areas in old meanders of stream channels. In the project area, they occur as a continuous body around the lower lying areas.

About 14 percent consists of dark-colored soils with moderately fine textures from the surface throughout. They are moderate to somewhat poorly drained. Normally they are adjacent to, but lie slightly above, the lower lying soils. These soils occur primarily in the southern part of the area, covering all of the Goose Pond subarea, extending into the southern part of the Cottonwood Slough subarea and occurring in a few sizable spots in the northern part of Cottonwood Slough. Frequent low spots require drainage but the soils are productive when drained.

About 73 percent, primarily in the Mounds Creek, Cache River, and Cottonwood Slough subareas, consists of soils that have been covered by lighter colored, more recently depositec silty textured surface materials to depths of 8 to 12 inches. The soils are poorly drained and because of the silty overwash material, their surface dries out somewhat sooner than that of the heavier textured soils. Frequent low wet spots occur, and the soils are of low inherent fertility. They respond well to drainage, however, and with treatment are moderately productive.

USDA estimated that if adequate flood protection and drainage were provided, 96 percent of all land in the A zone, 84 percent of all land in the B zone, and 87 percent of all land in the C zone would be open land. Assuming adequate flood protection and drainage, 2,200 acres of woodland are expected to be cleared, 2,100 acres of which would be drained. It was estimated that 8,400 acres of farmland (including the converted woodland) would be drained with project development. It is expected that 81 percent of all open land in the A zone, 80 percent of the open land in the B zone, and none of the open land in the C zone would be drained with the project. The changes in major land use and in the percentages of open land drained, by soil units, expected to occur with the project under assumptions of adequate flood control and drainage are shown in table 48.

As indicated in tables 49 and 50, net annual agricultural income in the Cairo Drainage District-Mounds, Mounds City Project Area in Illinois is expected to increase 87 percent and total agricultural production 74 percent with the project.

The total land development cost associated with project development was estimated by USDA at $281,000, with the annual equivalent cost at $31,000 including annual drainage maintenance at $9,000.

As shown in table 51, the annual increase in net agricultural income attributable to the project was estimated at $148,000, with a discounted value of $132,000. The annual discounted associated cost was estimated at $28,000.

TABLE 48.--Cairo Drainage District, Mounds and Mound City Project: Major land use and drainage, present and estimated future without and with project, soil units and zones

Item	All land in zone			Percentage of zone in--						Percentage of open land drained[1]		
				Open land			Woodland					
	A	B	C	A	B	C	A	B	C	A	B	C
	100 acres	*100 acres*	*100 acres*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Soil unit 1:												
Present................	10	4	3	666	64	65	34	36	35	0	0	0
Without project........	10	4	3	69	67	83	31	33	17	0	0	0
With project...........	10	4	3	92	92	83	8	8	17	74	80	0
Soil unit 2:												
Present................	13	3	1	99	87	100	1	13	0	0	0	0
Without project........	13	3	1	99	88	100	1	12	0	0	0	0
With project...........	13	3	1	100	99	100	0	1	0	90	90	0
Soil unit 6:												
Present................	52	46		89	42		11	58		0	0	
Without project........	52	46		90	48		10	52		0	0	
With project...........	52	46		95	82		5	18		79	79	
All:												
Present................	75	53	4	88	47	74	12	53	26	0	0	0
Without project........	75	53	4	89	52	87	11	48	13	0	0	0
With project...........	75	53	4	96	84	87	4	16	13	81	80	0

[1] Includes naturally and artificially drained land.

TABLE 49.--Cairo Drainage District, Mounds and Mound City Project: Estimated effects of project development on cropping systems[1]

Crop	Percentage change in acreage			Percentage change in production			Percentage change in net return		
	A zone	B zone	All land	A zone	B zone	All land	A zone	B zone	All land
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Cotton..................	3	75	21	37	96	52	177	183	179
Corn....................	19	90	40	100	216	131	109	235	143
Wheat...................	-3	199	24	50	375	91	50	420	96
Soybeans................	-10	15	-1	17	46	26	31	66	41
Hay.....................	4		4	89		43	50		50
Permanent pasture........	1	110	26	83	280	127	52	210	87
Idle....................	0	-100	-70						
Other...................	6	61	22						
Woodland................	-43	-66	-59				-43	-66	-41
All land............	0	0	0	59		74	73	122	87

[1] No change in acreage, production, or net return in C zone. "All land" includes C zone.

TABLE 50.--Cairo Drainage District, Mounds and Mound City Project: Estimated future crop acreages, crop production, and net return without and with project development

Crop	Without project			With project			Difference in net return	Percentage increase in net return
	Acres	Production[1]	Net return	Acres	Production[1]	Net return		
	100 acres	*1,000 units*	*1,000 dollars*	*100 acres*	*1,000 units*	*1,000 dollars*	*1,000 dollars*	*Percent*
Cotton...............	5	0.3	3	6	0.5	8	5	179
Corn.................	39	127	81	54	295	197	116	143
Wheat................	8	15	7	10	28	15	8	96
Soybeans.............	23	51	55	23	65	77	22	41
Hay..................	3	1	4	4	17	6	2	50
Permanent pasture....	7	76	5	9	172	9	4	87
Idle.................	2			1				
Other................	9			11				
Woodland.............	36		15	14		6	-9	-41
Total...........	132		170	132		318	148	87

[1] Cotton--500-pound bales; corn, soybeans, oats, and grain sorghum--bushels; rice--hundredweights; beef--pounds.
[2] Duplicated acreage.

TABLE 51.--Cairo Drainage District--Mounds and Mound City Area: Project summary

Item	Amount
Drainage operations:	
Woodland converted to open	*Acres*
cropland	2,200
Farmland drained	8,400
Associated costs:	
Initial:	*Dollars*
Woodland conversion	145,000
Farm drainage installations	81,000
Group drainage installations	55,000
Total associated costs	281,000
Associated costs--Continued	
Annual equivalent:	*Dollars*
Conversion	8,000
Farm drainage	8,000
Group drainage	6,000
Annual farm drainage maintenance	9,000
Total annual costs	31,000
Annual increase in net farm income	148,000
Discounted value of:	
Annual increase in net farm income	132,000
Annual associated costs	28,000
Unadjusted benefits	104,000

PROPOSED WATER-CONTROL PROJECTS IN KENTUCKY

West Kentucky Tributaries Project

The West Kentucky Tributaries Project (fig. 26) consists of proposed channel enlargement and improvement on Mayfield and Obion Creeks and Bayou du Chien in western Kentucky. These streams drain portions of Ballard, Carlisle, Fulton, Graves, and McCracken Counties. The land area involved contains 88,100 acres.

Soil erosion on the uplands surrounding the three West Kentucky tributaries is considerable. Improper land use, lack of complete conservation, farming practices, and especially the susceptibility of the loess soils to erosion are the chief causes. Sediments are deposited at the bases of the originating slopes and are also carried on down to the flood plains and channels of these tributary streams.

Several attempts at drainage in the project area have been made but none of the improvements are currently satisfactory. Major drainage outlets will need to be provided before satisfactory farm drainage can be accomplished.

General farming predominates throughout the project area. With adequate drainage, major crops of the bottom lands are corn, soybeans, hay, and pasture. In the poorly drained areas, the present level of agricultural development is low, and much of the land has remained in or reverted to woodland. Because of the flood hazard and the varying drainage conditions in parts of the area, crop returns are highly variable and often low, resulting in large areas of land remaining idle for varying periods of time. In the lower reaches of the three stream basins, from 80 to 90 percent of the farms are large. In the upper reaches the reverse is true--from 80 to 90 percent of the farms are small.

Poorly drained, medium-textured alluvial soils predominate throughout the bottom land in the three stream basins. These soils cover about three-fourths of the project, involving most of the land above the contour of the flood of record, more than 90 percent of the land in the zone subject to flooding, which the proposed project is designed to benefit, and about 50 percent of the land in the zone of frequent flooding, which would not benefit.

The entire project area of the three West Kentucky tributaries consists of 45 percent open land and 55 percent woodland. On the open land, the well-drained soils are used mainly for corn and hay, while the poorly drained soils are used chiefly for soybeans and grasses. On the better soils in the bottoms, corn is often grown year after year. In other fields a rotation of hay followed by corn or soybeans is sometimes followed.

Obion Creek and Bayou du Chien subproject area

This subproject area contains 51,100 acres. About 10 percent of the area lies in the A zone, about 27 percent is in the B zone, and 63 percent is in the C zone. USDA estimated that if

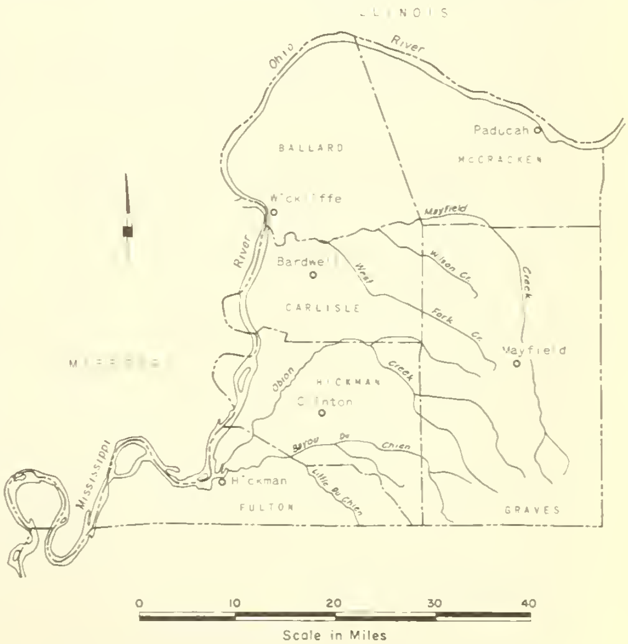


Figure 26.--Project area location, West Kentucky Tributaries.

adequate flood protection and drainage were provided in the area, 71 percent of all land in the A zone, 44 percent of all land in the B zone, and 43 percent of all land in the C zone would be open land. Changes in major land use and in the percentage of open land drained, by soil units, estimated to take place with project development under assumptions of adequate flood protection and drainage are shown in table 52.

TABLE 52.--Obion Creek and Bayou du Chien Basins: Major land use and drainage, present and estimated future without and with project, soil units and zones

Item	All land in zone			Percentage of zone in--						Percentage of open land drained[1]		
				Open land			Woodland					
	A	B	C	A	B	C	A	B	C	A	B	C
	100 acres	*100 acres*	*100 acres*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Soil unit 1:												
Present			83			10			90			0
Without project			83			18			82			0
With project			83			18			82			0
Soil unit 2:												
Present			8			89			11			0
Without project			8			100			0			0
With project			8			100			0			0
Soil unit 5:												
Present			20			60			40			0
Without project			20			80			20			0
With project			20			80			20			0
Soil unit 6:												
Present			19			17			83			0
Without project			19			17			83			0
With project			19			17			33			0
Soil unit 7:												
Present	38	63	58	74	58	78	26	42	22	9	10	0
Without project	38	63	58	68	60	82	32	40	18	13	15	0
With project	38	63	58	79	68	82	21	32	18	88	88	0
Soil unit 8:												
Present	13	65	94	37	11	22	63	89	78	3	3	0
Without project	13	65	94	37	11	22	63	89	78	4	4	0
With project	13	65	94	47	25	22	53	75	78	78	79	0
Soil unit 9:												
Present			5			93			7			0
Without project			5			94			6			0
With project			5			94			6			0
Soil unit 10:												
Present			22			84			16			0
Without project			22			84			16			0
With project			22			84			16			0
Soil unit 11:												
Present			9			30			70			0
Without project			9			52			48			0
With project			9			52			48			0
Soil unit 13:												
Present			1			23			67			0
Without project			1			23			67			0
With project			1			23			67			0
Soil unit 14:												
Present	1	10	2	22	1	1	78	99	99	100	0	0
Without project	1	10	2	44	1	1	56	99	99	100	0	0
With project	1	10	2	66	20	1	34	80	99	100	100	0
All:												
Present	52	138	321	64	32	38	36	68	62	8	9	0
Without project	52	138	321	60	32	48	40	68	57	12	13	0
With project	52	138	321	71	44	43	29	56	57	86	86	0

[1] Includes naturally and artificially drained land.

As shown in tables 53 and 54, net agricultural income in the subproject area is expected to increase 21 percent and total agricultural production 23 percent with project development.

If the proposed flood-control-drainage project is installed, an estimated 2,200 acres of woodland could be converted to open land and drained. A total of 7,400 acres of farmland (including the converted woodland) would be drained with the project. The total associated costs of land development in the Obion Creek and Bayou du Chien subproject area were estimated by USDA at $316,700, with the annual equivalent at $52,800, including $18,000 for annual drainage maintenance.

As shown in table 55, the annual increase in net agricultural income was estimated at $127,300. The discounted values of annual increase in net agricultural income and of annual equivalent associated costs were estimated by USDA at $100,900 and $41,900, respectively.

TABLE 53.--Obion Creek and Bayou du Chien Basins: Estimated effects of project development on cropping systems[1]

Crop	Percentage change in acreage			Percentage change in production			Percentage change in net return		
	A zone	B zone	All land	A zone	B zone	All land	A zone	B zone	All land
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Corn......................	35	182	37	91	277	58	94	292	60
Soybeans..................	43	109	12	77	132	16	89	132	18
Hay.......................	69	222	112	136	319	173	259	432	255
Permanent pasture.........	-7	-66	-20	15	-62	-17	16	-61	-17
Idle......................	-72	-97	-53						
Other.....................	5	0	5						
Woodland..................	-27	-18	-7	-27	-17	-8	-23	-17	-8
All land..............	0	0	0	62	69	23	63	58	21

[1] No change in acreage, production, or net return in C zone. "All land" includes C zone.

TABLE 54.--Obion Creek and Bayou du Chien Basins: Estimated future crop acreages, crop production, and net return without and with project development

Crop	Without project			With project			Difference in net return	Percentage increase in net return
	Acres	Production[1]	Net return	Acres	Production[1]	Net return		
	100 acres	*1,000 units*	*1,000 dollars*	*100 acres*	*1,000 units*	*1,000 dollars*	*1,000 dollars*	*Percent*
Corn................	81	367	225	111	580	361	136	60
Soybeans............	45	109	119	51	127	140	21	18
Hay.................	6	1	1	11	2	5	4	400
Permanent pasture....	71	1,348	133	57	1,111	110	-23	-17
Idle................	10			5				
Other...............	1			1				
Woodland............	297		126	275		115	-11	-9
Total...........	511		604	511		731	127	21

[1] Cotton--500-pound bales; corn, soybeans, oats, and grain sorghum--bushels; rice--hundredweights; beef--pounds.

TABLE 55.--Obion Creek and Bayou du Chien Basin: Project summary

Item	Amount
Drainage operations:	
Woodland converted to open cropland........................	*Acres* 2,200
Farmland drained.................	7,400
Associated costs:	
Initial:	*Dollars*
Woodland conversion.............	145,000
Farm drainage installations.....	171,700
Group drainage installations....	0
Total associated costs........	316,700
Annual equivalent:	
Conversion......................	12,600
Farm drainage...................	22,200
Group drainage..................	0
Annual farm drainage maintenance..	18,000
Total annual costs............	52,800
Annual increase in net farm income..	127,300
Discounted value of:	
Annual increase in net farm income	100,900
Annual associated costs...........	41,900
Unadjusted benefits.............	59,000

Mayfield Creek subproject area

The Mayfield Creek subproject area contains 36,900 acres. About 15 percent of the land in the area lies within the A zone, 50 percent is in the B zone, and 35 percent is in the C zone. USDA estimated that if adequate flood protection and drainage were provided, 95 percent of all land in the A zone, 60 percent of all land in the B zone, and 52 percent of all land in the C zone would be open land. Changes in major land use and in the percentage of open land drained, by soil units, estimated to occur with project development under assumptions of adequate flood protection and drainage, are shown in table 56.

As shown in tables 57 and 58, net agricultural income in the subproject area is expected to increase 41 percent and total agricultural production 38 percent with project development.

If the proposed flood control-drainage project were installed, it was estimated that 2,400 acres of woodland would be converted to open land and drained. A total of 12,000 acres of farmland (including the converted woodland) would be drained with the project. The total associated costs of land development in the Mayfield Creek subproject area were estimated by USDA at $455,200, with the annual equivalent at $82,600, including $27,700 for annual drainage maintenance.

TABLE 56.--Mayfield Creek Basin: Major land use and drainage, present and estimated future without and with project, soil units and zones

Item	All land in zone			Percentage of zone in--						Percentage of open land drained[1]		
				Open land			Woodland					
	A	B	C	A	B	C	A	B	C	A	B	C
	100 acres	*100 acres*	*100 acres*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Soil unit 5:												
Present.................			14			77			23			0
Without project.........			14			88			12			0
With project............			14			88			12			0
Soil unit 6:												
Present.................			25			9			91			0
Without project.........			25			54			46			0
With project............			25			54			46			0
Soil unit 7:												
Present.................	40	81	41	89	76	75	11	24	25	13	10	0
Without project.........	40	81	41	85	76	72	15	24	28	16	13	0
With project............	40	81	41	98	86	72	2	14	28	78	88	0
Soil unit 8:												
Present.................	14	99	44	80	33	21	20	67	79	3	3	
Without project.........	14	99	44	81	33	20	19	67	80	4	4	
With project............	14	99	44	88	43	20	12	57	80	79	79	
Soil unit 9:												
Present.................			1			81			19			
Without project.........			1			91			9			
With project............			1			91			9			

See footnote at end of table.

TABLE 56.--Mayfield Creek Basin: Major land use and drainage, present and estimated future without and with project, soil units and zones--Continued

Item	All land in zone			Percentage of zone in--						Percentage of open land drained[1]		
				Open land			Woodland					
	A	B	C	A	B	C	A	B	C	A	B	C
	100 acres	*100 acres*	*100 acres*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Soil unit 10:												
Present			1			100			0			
Without project			1			92			8			
With project			1			92			8			
Soil unit 14:												
Present		6	3		0	0		100	100		0	0
Without project		6	3		0	0		100	100		0	0
With project		6	3		9	0		91	100		100	0
All:												
Present	54	186	129	87	51	43	13	49	57	11	8	0
Without project	54	186	129	84	51	52	16	49	48	13	10	0
With project	54	186	129	95	60	52	5	40	48	78	84	0

[1] Includes naturally and artificially drained land.

TABLE 57.--Mayfield Creek Basin: Estimated effects of project development on cropping systems[1]

Crop	Percentage change in acreage			Percentage change in production			Percentage change in net return		
	A zone	B zone	All land	A zone	B zone	All land	A zone	B zone	All land
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Corn	32	43	25	94	102	60	104	114	66
Soybeans	51	197	48	73	283	57	78	321	62
Hay	11	29	18	45	85	54	84	202	111
Permanent pasture	-11	12	-10	16	17	14	17	18	15
Idle	-71	-98	-71						
Other	2	0	2						
Woodland	-70	-19	-14				-60	-19	-13
All land	0	0	0	63	62	38	68	66	41

[1] No change in acreage, production, or net return in C zone. "All land" includes C zone.

TABLE 58.--Mayfield Creek Basin: Estimated future crop acreages, crop production, and net return without and with project development

Crop	Without project			With project			Difference in net return	Percentage increase in net return
	Acres	Production[1]	Net return	Acres	Production[1]	Net return		
	100 acres	*1,000 units*	*1,000 dollars*	*100 acres*	*1,000 units*	*1,000 dollars*	*1,000 dollars*	*Percent*
Corn.................	103	421	253	129	674	420	167	66
Soybeans.............	18	49	53	27	77	85	32	60
Hay..................	16	3	3	19	4	8	5	167
Permanent pasture....	52	1,005	99	47	1,141	113	14	14
Idle.................	14			5				
Other................	3			3				
Woodland.............	163		98	139		85	-13	-13
Total...........	369		506	369		711	205	41

[1] No change in acreage, production, or net return in C zone. "All land" includes C zone.

As indicated in table 59, the annual increase in net agricultural income was estimated at $205,000. The discounted values of annual increase in net agricultural income and of annual associated costs were estimated by USDA at $162,400 and $65,500, respectively.

TABLE 59.--Mayfield Creek Basin: Project summary

Item	Amount
Drainage operations:	
Woodland converted to open cropland......................	*Acres* 2,400
Farmland drained.................	12,200
Associated costs:	
Initial:	*Dollars*
Woodland conversion............	177,400
Farm drainage installations.....	277,800
Group drainage installations....	0
Total associated costs........	455,200
Annual equivalent:	
Conversion.....................	18,900
Farm drainage..................	36,000
Group drainage.................	0
Annual farm drainage maintenance..	27,700
Total annual costs...........	82,600
Annual increase in net farm income..	205,000
Discounted value of:	
Annual increase in net farm income.........................	162,400
Annual associated costs...........	65,500
Unadjusted benefits...........	96,900

Mississippi River and Tributaries Project Area in Kentucky

The Mississippi River and Tributaries Project area in Kentucky contains about 88,000 acres, of which 12 percent lies in the A zone, 37 percent lies in the B zone, and 51 percent in the C zone. USDA estimated that with adequate flood protection and drainage, 83 percent of all land in the A zone, 54 percent of all land in the B zone, and 45 percent of all land in the C zone would be open land. Changes in major land use and in the percentage of open land drained, by soil units, estimated to occur with project development under assumptions of adequate flood protection and drainage are shown in table 60.

As shown in tables 61 and 62, net agricultural income and total agricultural production within the project area in Kentucky are expected to increase 30 percent with project development.

If the proposed flood-control-drainage project were installed, it is estimated that 4,600 acres of woodland would be converted to open land and drained. Expected to be drained with the project are 19,600 acres of farmland (including the converted woodland). Total associated costs of land development within the project area in Kentucky were estimated by the USDA at $772,000, with the annual equivalent at $136,000, including $45,700 for annual drainage maintenance.

As indicated in table 63, the annual increase in net agricultural income is estimated at $332,000. The discounted values of annual increase in net agricultural income and of annual associated costs were estimated at $263,000 and $107,000, respectively.

TABLE 60.--Mississippi River and Tributaries Project, Kentucky: Major land use and drainage, present and estimated future without and with project, soil units and zones

Item	All land in zone			Percentage of zone in-- Open land			Percentage of zone in-- Woodland			Percentage of open land drained[1]		
	A	B	C	A	B	C	A	B	C	A	B	C
	100 acres	*100 acres*	*100 acres*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Soil unit 1:												
Present			83			10			90			0
Without project			83			18			82			0
With project			83			18			82			0
Soil unit 2:												
Present			8			88			12			0
Without project			8			100			0			0
With project			8			100			0			0
Soil unit 5:												
Present			34			68			32			0
Without project			34			82			18			0
With project			34			82			18			0
Soil unit 6:												
Present			44			11			89			0
Without project			44			36			64			0
With project			44			36			64			0
Soil unit 7:												
Present	78	144	99	82	68	77	18	32	23	11	10	0
Without project	78	144	99	77	69	79	23	31	21	15	13	0
With project	78	144	99	88	78	79	12	22	21	88	87	0
Soil unit 8:												
Present	27	164	138	59	24	22	41	76	78	0	2	0
Without project	27	164	138	59	24	21	41	76	79	6	5	0
With project	27	164	138	70	36	21	30	64	79	79	80	0
Soil unit 9:												
Present			6			83			17			0
Without project			6			83			17			0
With project			6			83			17			0
Soil unit 10:												
Present			23			87			13			0
Without project			23			87			13			0
With project			23			87			13			0
Soil unit 11:												
Present			9			33			67			0
Without project			9			56			44			0
With project			9			56			44			0
Soil unit 13:												
Present			1			0			100			0
Without project			1			0			100			0
With project			1			0			100			0
Soil unit 14:												
Present	1	16	5	0	0	0	100	100	100	0	0	0
Without project	1	16	5	0	0	0	100	100	100	0	0	0
With project	1	16	5	0	12	0	100	88	100	0	100	0
All:												
Present	106	324	450	75	43	39	25	57	61	9	8	0
Without project	106	324	450	72	43	45	28	57	55	13	11	0
With project	106	324	450	83	54	45	17	46	55	86	84	0

[1] Includes naturally and artificially drained land.

TABLE 61.--Mississippi River and Tributaries Project, Kentucky: Estimated effects of project development on cropping systems[1]

Crop	Percentage change in acreage			Percentage change in production			Percentage change in net return		
	A zone	B zone	All land	A zone	B zone	All land	A zone	B zone	All land
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Corn	34	75	30	93	144	59	99	158	63
Soybeans	50	162	24	75	198	29	82	208	31
Hay	50	58	36	64	144	50	119	282	225
Permanent pasture	-10	-33	-15	16	-17	-4	17	-15	-4
Idle	-75	-100	-42						
Other	0	0	0						
Woodland	-40	-70	-10	-44	-19	-11	-38	-18	-11
All land	0	0	0	63	65	30	66	63	30

[1] No change in acreage, production, or net return in C zone. "All land" includes C zone.

TABLE 62.--Mississippi River and Tributaries Project, Kentucky: Estimated future crop acreages, crop production, and net return without and with project development

Crop	Without project			With project			Difference in net return	Percentage increase in net return
	Acres	Production[1]	Net return	Acres	Production[1]	Net return		
	100 acres	*1,000 units*	*1,000 dollars*	*100 acres*	*1,000 units*	*1,000 dollars*	*1,000 dollars*	*Percent*
Corn	184	788	478	240	1,254	781	303	63
Soybeans	63	158	172	78	204	225	53	31
Hay	22	4	4	30	6	13	9	225
Permanent pasture	123	2,353	232	104	2,252	223	-9	-4
Idle	24			10				
Other	4			4				
Woodland	460		224	414		200	-24	-11
Total	880		1,110	880		1,442	332	30

[1] Cotton--500-pound bales; corn, soybeans, oats, and grain sorghum--bushels; rice--hundredweights; beef--pounds.

TABLE 63.--Mississippi River and Tributaries Project Area in Kentucky: Project summary

Item	Amount	Item	Amount
Drainage operations:		Associated costs--Continued	
Woodland converted to open cropland	*Acres* 4,600	Annual equivalent:	*Dollars*
Farmland drained	19,600	Conversion	32,000
		Farm drainage	58,000
		Group drainage	0
		Annual farm drainage maintenance	46,000
Associated costs:		Total annual costs	136,000
Initial:	*Dollars*	Annual increase in net farm income	332,000
Woodland conversion	322,000	Discounted value of:	
Farm drainage installations	450,000	Annual increase in net farm income	263,000
Group drainage installations	0	Annual associated costs	107,000
Total associated costs	772,000	Unadjusted benefits	156,000

The physical conditions that affect drainage reclamation become more complex as the lower Mississippi River Basin is traversed southward. One physical condition related to the complexity of the drainage problem in Louisiana is the decrease in gradient from north to south. Considered from the standpoint of drainage engineering, this difference in gradient is important. The less steep the slope the slower the water velocity and the greater the need for ditches having large capacities. Furthermore, with decreased slope the dumping of floodwater becomes more difficult. Outlet ditches required to dispose of excess water must have longer outlets. Because drainage in the alluvial valley is from north to south, streams increase in size as they flow southward. Because of the larger amounts of water and the flatter topography, water-control problems are somewhat more complex in Louisiana than they are in States farther north.

Beouf-Tensas-Macon Basin

The portion of the Boeuf-Tensas-Macon Basin (fig. 27) lying in Louisiana consists of about 550 miles of streams. The proposed project consists of channel improvement including enlargement, snagging, and clearing of the principal drainage arteries--Boeuf River, Bayou Lafourche, Big and Colewa Creek, Tensas River, and Bayou Macon. About 1,146,600 acres are included in the project area. Of this acreage, 478,800 acres lie above the contour of the flood of record and are not subject to flooding, although some of this land requires drainage. Subject to

Figure 27.--Project area location, Boeuf-Tensas-Macon Basin, Louisiana.

flooding in some degree are 485,800 acres, and some of this land needs drainage. Considered to be not affected by the proposed drainage works are 182,000 acres in the low sump area.

Soils of the Boeuf-Tensas-Macon Basin vary in physical characteristics according to geographic location and origin. Soils in the geographic area known as the Ouachita Cone were derived from sediments of the Arkansas, Ouachita, and Mississippi Rivers. The alternate flooding of one river or another or all rivers at once, each carrying different sediments, together with the shifting of stream channels and consequent reworking of material, has given rise to soils that differ chemically and physically from soils along the individual rivers. Soils occupying Macon Ridge are loessial. These soils are older geologically than those of the bottom lands and differ considerably in profile development, mineral content, and fertility. The Boeuf River, Bayou Lafourche, and Big and Colewa Creek subproject areas have soils of the loessial terrace position. Soils of the Tensas River and Bayou Macon subproject areas are very fertile bottom-land soils deposited by the Mississippi River and its tributaries in recent geological times.

The fine-textured, very slowly permeable, poorly drained soils of the bottom lands within the basin, which occupy the lower elevations, are difficult to drain, manage, and irrigate. These soils are low in organic matter, and as the organic matter decreases, management difficulties increase. When protected from overflow, and properly drained and managed, however, they produce fair yields of pasture, oats, and corn, and when irrigated, fair to good yields of pasture. Without proper management, these soils soon lose organic matter, become impervious and less productive, and are often abandoned. The Boeuf-Tensas-Macon Basin has 233,400 acres of this type of soil (mapped as soil unit 1a). Of this land 27,800 acres lie above the contour of the flood of record, free from any flood hazard; 114,800 acres are subject to some degree of flooding which would be alleviated by construction of the proposed project; and 90,800 acres are in the sump area and would remain undrained. At the higher elevations within the basin the bottom-land soils are somewhat more productive, and although they have the same physical limitations as those lying at lower elevations, when properly drained and managed, they produce fair to medium yields of pasture and fair yields of corn, oats, cotton, and soybeans. The basin contains 450,300 acres with this type of soil, of which 120,700 acres lie above the contour of the flood of record; 258,900 acres are subject to flooding that would be alleviated by the project works; and 70,700 acres are in the sump area and would not benefit.

The moderately fine-textured, somewhat poorly drained bottom-land soils in the basin are moderately difficult to drain, manage, and irrigate. As the organic-matter content of these soils is lowered, management difficulties increase. When properly drained and managed, however, these soils produce moderate to high yields of pasture, corn, cotton, soybeans, and oats. In the area are 81,100 acres of these soils, 47,400 acres of which are above the contour of the flood of record and thus free from flooding; 30,000 acres are subject to flooding, which would be relieved by the proposed project; and 3,700 acres are in the sump area, which would not benefit.

The medium-textured, moderately well and well-drained soils of the bottom lands are usually rather easy to drain and to manage. When properly drained, these soils produce moderate to high yields of all crops adapted to the area, although they require a more complete fertilizer than the heavier soils. The area has 158,800 acres of this type of soil. Of this acreage, 119,400 acres are free from flooding; 32,000 acres are subject to flood and overflow, and 7,400 acres are in the sump area.

A part of the area consists of medium and moderately coarse-textured, well-drained soils. These soils occupy bottom land and natural levee or low terrace positions. In general, these soils require no drainage and are easily managed. Under good management, they produce good yields of all crops adapted to the area. They are ideally suited to irrigation. The basin has 21,900 acres of these soils. In the zone in which there is no flood hazard are 21,200 acres; 600 acres are subject to flood and overflow which would be alleviated by the project; and 100 acres would remain undrained.

Lands in the Boeuf-Tensas-Macon Basin are now devoted largely to timber production, with 63 percent of the basin in woodland and 37 percent in open land. The percentage in woodland varies according to texture and drainage characteristics of the soil. On the heavier-textured, poorly drained soils, 89 percent is in woods, while all land on the coarse-textured excessively drained soils has been cleared.

Assuming adequate flood protection and drainage, USDA estimated that 83 percent of all land in the A zone, 49 percent of all land in the B zone, and 6 percent of all land in the C zone would be open land. Under these assumptions, it is expected that 90 percent of the open land in the A zone, 81 percent of the open land in the B zone, and none of the open land in the C zone would be drained with the project. The changes in major land use and in the percentage of open land drained, by soil units, expected with project development are shown in table 64.

USDA estimated that net agricultural income would increase 73 percent and total agricultural production 60 percent if the proposed project were constructed and if adequate flood protection and drainage were provided. Changes in crop acreages, production, and net income expected to occur with project development are shown in tables 65 and 66.

Of 198,600 acres of woodland cleared, 184,900 acres are expected to be drained with the

project. Of the farmland, 313,000 acres (including the converted woodland) are anticipated to be drained. Total associated costs of land development necessitated by project development were estimated by USDA at $28,822,000 with the annual equivalent cost, including annual drainage maintenance, at $2,209,000. As indicated in table 67, the total discounted annual increase in net agricultural income was estimated at $3,936,000. The total discounted annual associated costs are estimated at $1,197,000.

TABLE 64.--Boeuf-Tensas-Macon Basin: Major land use and drainage, present and estimated future without and with project, soil units and zones

Item	All land in zone			Percentage of zone in--						Percentage of open land drained[1]		
				Open land			Woodland					
	A	B	C	A	B	C	A	B	C	A	B	C
	100 acres	*100 acres*	*100 acres*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Soil unit 1:												
Present..................	1,485	3,737	1,615	31	9	2	69	91	98	26	18	0
Without project.........	1,485	3,737	1,615	33	10	2	67	90	98	30	21	0
With Project............	1,485	3,737	1,615	62	38	2	38	62	98	87	77	0
Soil unit 2:												
Present..................	474	300	37	89	78	18	11	22	82	34	12	0
Without project.........	474	300	37	91	81	18	9	19	82	40	18	0
With project............	474	300	37	99	95	18	1	5	82	94	90	0
Soil unit 5:												
Present..................	1,194	320	74	95	68	42	5	32	58	34	17	0
Without project.........	1,194	320	74	99	74	42	1	26	58	94	27	0
With project............	1,194	320	74	99	93	42	1	7	58	97	91	0
Soil unit 8:												
Present..................	2	11	34	77	23	3	23	77	97	0	0	0
Without project.........	2	11	34	82	23	3	18	77	97	11	0	0
With project............	2	11	34	86	46	3	14	54	97	54	70	0
Soil unit 9:												
Present..................	213	39	6	95	84	48	5	16	52	8	7	0
Without project.........	213	39	6	98	88	48	2	12	52	36	27	0
With project............	213	39	6	100	98	48	0	2	52	92	92	0
Soil unit 10:												
Present..................	1,206	445	53	53	45	50	47	55	50	16	7	0
Without project.........	1,206	445	53	59	52	50	41	48	50	24	19	0
With project............	1,206	445	53	82	76	50	18	24	50	82	80	0
Soil unit 11:												
Present..................	212	6	1	99	100	100	1	0	0	36	11	0
Without project.........	212	6	1	100	100	100	0	0	0	99	27	0
With project............	212	6	1	100	100	100	0	0	0	99	93	0
Soil unit 12:												
Present..................	2	--	--	100	--	--	0	--	--	81	--	--
Without project.........	2	--	--	100	--	--	0	--	--	100	--	--
With project............	2	--	--	100	--	--	0	--	--	100	--	--
All:												
Present..................	4,788	4,858	1,820	64	21	6	36	79	94	27	14	0
Without project.........	4,788	4,858	1,820	68	23	6	32	77	94	58	21	0
With project............	4,788	4,858	1,820	83	49	6	17	51	94	90	81	0

[1] Includes naturally and artificially drained land.

TABLE 65.--Boeuf-Tensas-Macon Basin: Estimated effects of project development on cropping systems[1]

Crop	Percentage change in acreage			Percentage change in production			Percentage change in net return		
	A zone	B zone	All land	A zone	B zone	All land	A zone	B zone	All land
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Cotton......................	-1	8	2	21	61	34	72	226	124
Corn........................	25	177	57	49	292	93	55	349	106
Soybeans....................	36	263	86	57	431	122	60	498	131
Oats........................	36	187	65	54	302	95	71	414	123
Oats pasture................	47	344	96	60	467	115	57	465	115
Permanent pasture...........	12	16	13	36	59	42	32	59	39
Idle........................	-26	-22	-24	--	--	--	--	--	--
Other.......................	23	110	44	--	--	--	--	--	--
Woodland....................	-49	-33	-28	-49	-33	-28	-40	-33	-26
All land..............	0	0	0	40	121	60	48	155	73

[1] No change in acreage, production, or net return in C zone. "All land" includes C zone.

TABLE 66.--Boeuf-Tensas-Macon Basin: Estimated future crop acreages, crop production, and net return without and with project development

Crop	Without project			With project			Difference in net return	Percentage increase in net return
	Acres	Production[1]	Net return	Acres	Production[1]	Net return		
	100 acres	*1,000 units*	*1,000 dollars*	*100 acres*	*1,000 units*	*1,000 dollars*	*1,000 dollars*	*Percent*
Cotton...............	379	26	243	385	35	544	301	124
Corn.................	745	2,719	1,499	1,167	5,251	3,089	1,590	106
Soybeans.............	822	2,122	2,686	1,529	4,706	6,209	3,523	131
Oats.................	811	3,188	769	1,335	4,613	1,718	949	123
Oats pasture.........	[2] (385)	7,753	656	(756)	16,696	1,409	753	115
Permanent pasture....	1,192	26,368	2,216	1,343	37,338	3,084	868	39
Idle.................	94	--	--	71	--	--	--	--
Other................	447	--	--	646	--	--	--	--
Woodland.............	6,976	--	2,096	4,990	--	1,558	-538	-26
Total...........	11,466	--	10,165	11,466	--	17,611	7,446	73

[1] Cotton--500-pound bales; corn, soybeans, oats, and grain sorghum--bushels; rice--hundredweights; beef--pounds.
[2] Duplicated acreage.

TABLE 67.--Boeuf-Tensas-Macon Basin, Louisiana: Project summary

Item	Amount
Drainage operations:	
Woodland converted to open	*Acres*
cropland........................	198,600
Farmland drained.................	313,000
Associated costs:	
Initial:	*Dollars*
Woodland conversion............	23,754,300
Farm drainage installations....	5,038,800
Group drainage installations...	28,800
Total associated costs.......	28,821,900
Annual equivalent:	
Conversion.....................	1,088,900
Farm drainage..................	598,000
Group drainage.................	3,200
Annual farm drainage maintenance.	518,600
Total annual costs...........	2,208,700
Annual increase in net farm income.	7,446,000
Discounted value of:	
Annual increase in net farm	
income........................	3,936,000
Annual associated costs..........	1,197,000
Unadjusted benefits............	2,738,000

Red River Backwater Area

The Red River Backwater Protection Project is proposed to protect an area of about 620,000 acres from backwater flooding. This proposed project is divided into two subproject areas: One of about 231,800 acres in the New Orleans Corps of Engineers District; the other, of about 388,200 acres in the Vicksburg Corps of Engineers District. Each area was studied independently and considered as a separate reporting unit.

Red River Backwater Protection Project--New Orleans District

The Red River Backwater Protection Project in the New Orleans District (fig. 28) consists of a ring levee in the Larto Lake to Jonesville Area and two loop levees, one in the North Point to Dunlap Area, and the other in the Lake Long to Bordelonville Area. The three levees would have control structures and would include an overtopping section to permit storage of backwater in the protected area when floodwaters exceed the design condition. The frequency of overtopping is expected to be not greater than once in the lifetime of the project. Therefore, the area would receive practically complete protection from backwater flooding.

This area consists of about 200,600 acres of fine-textured, very slowly permeable, poorly drained bottom-land soils, which are fertile but difficult to drain and manage. When protected from overflow, drained and well managed, however, the soils produce moderate to high yields of all crops grown in the area. About 108,500 acres of this land, which are subject to flooding in varying degrees of frequency, would be protected by the proposed project works. The remaining 92,100 acres are situated in a low sump area and would not benefit.

About 6,600 acres consist of moderately fine-textured, somewhat poorly drained bottom-land soils. These soils are very fertile but require drainage and good managent to produce high yields of adapted crops. Of this acreage, 6,300 acres would be protected by the project and 300 would not benefit.

About 23,800 acres comprise medium-textured, moderately well- and well-drained bottom-land soils. These soils are fertile, productive, easy to manage, and under good management would produce high yields of all crops grown in the area. Of this land, 23,700 acres would receive protection from the proposed project works; 100 acres would remain as undrained land.

About 700 acres comprise alluvial sands and detrimental deposits that have little agricultural

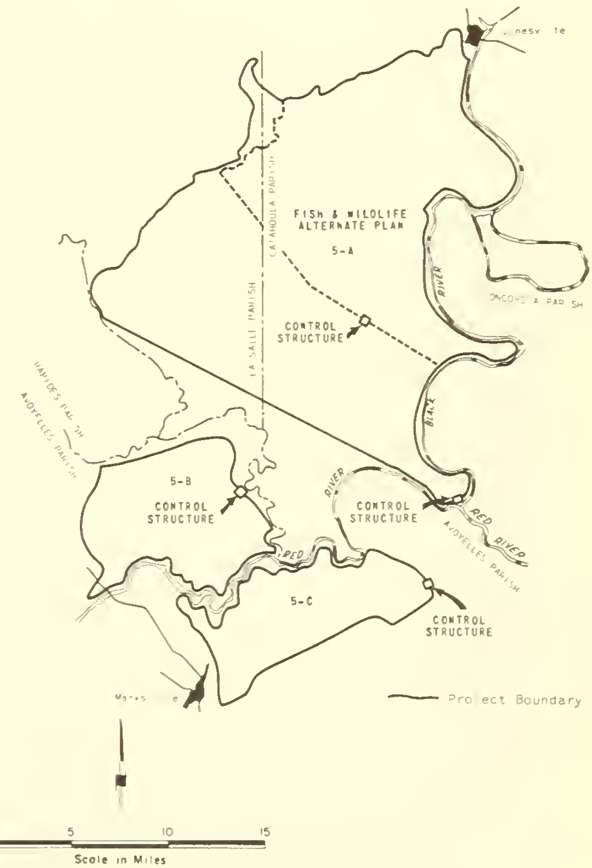


Figure 28.--Project area location, Red River Backwater Area, New Orleans Corps of Engineers District.

value. All of this land is in the zone that would receive flood protection with the project.

The area contains 100 acres of medium-textured, well and moderately well-drained loessial terrace soils that can be rather easily drained and managed. All of this land is in the zone that would receive flood protection with the project.

Of the total land area in the New Orleans District portion of the proposed project, 32,900 acres, or 14 percent, is open land.

USDA estimated that if adequate flood protection and drainage were provided in this part of the Red River Backwater Area, 46 percent of all land in the B zone and 1 percent of all land in the C zone would be open land. No land lies within the A zone in this part of the project area. It was also estimated that 87 percent of all open land in the B zone would be drained with the project. None of the land in the C zone is expected to be drained. Changes in major land use and in the percentage of open land drained expected to occur with project development are shown in table 68.

USDA estimated that under assumptions of adequate flood protection and drainage, net agricultural income in the area would increase 91 percent and total agricultural production 79 percent. Changes in crop acreages, production, and net income for each zone of the area are shown in tables 69 and 70.

With project development, 29,700 acres of woodland are expected to be cleared and to participate in the drainage project. It is anticipated that with the project, 37,700 acres of farmland (including the 29,700 acres of woodland expected to be cleared and drained) would be drained. USDA estimated the total associated costs of the project to be $2,627,000, with an annual equivalent of $261,500 including annual cost of drainage maintenance.

As indicated in table 71, the discounted value of the annual increase in net agricultural income owing to the project was estimated at $816,000, with the discounted value of annual associated costs estimated at $260,600.

TABLE 68.--Red River Backwater Area--New Orleans District: Major land use and drainage, present and estimated future without and with project, soil units and zones

Item	All land in zone			Percentage of zone in--						Percentage of open land drained[1]		
				Open land			Woodland					
	A	B	C	A	B	C	A	B	C	A	B	C
	100 acres	*100 acres*	*100 acres*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Soil unit 1:												
Present		1,085	921		6	0		94	100		5	0
Without project		1,085	921		6	0		94	100		8	0
With project		1,085	921		32	0		68	100		80	0
Soil unit 2:												
Present		63	3		77	98		23	2		14	0
Without project		63	3		83	98		17	2		33	0
With project		63	3		93	98		7	2		93	0
Soil unit 5:												
Present		237	1		86	0		14	100		13	0
Without project		237	1		91	0		9	100		50	0
With project		237	1		97	0		3	100		95	0
Soil unit 9:												
Present		1			100			0			100	
Without project		1			100			0			100	
With project		1			100			0			100	
Soil unit 13:												
Present		7			79			21			100	
Without project		7			92			8			100	
With project		7			92			8			100	
All:												
Present		1,393	925		23	1		77	99		13	0
Without project		1,393	925		25	1		75	99		40	0
With project		1,393	925		46	1		54	99		87	0

[1] Includes naturally and artificially drained land.

TABLE 69.--Red River Backwater Area--New Orleans District--Estimated effects of project development on cropping systems[1]

Crop	Percentage change in acreage			Percentage change in production			Percentage change in net return		
	A zone	B zone	All land	A zone	B zone	All land	A zone	B zone	All land
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Cotton....................		6	6		22	22		43	43
Corn......................		59	59		83	83		94	94
Soybeans..................		145	145		190	190		201	201
Oats......................		173	173		217	217		243	243
Oats pasture..............		199	199		250	250		253	253
Permanent pasture.........		94	186		143	143		148	140
Idle......................		21	21						
Other.....................		87	85						
Woodland..................		-28	-15		-28	-28		-28	-15
All land..............		0	0		79	79		108	91

[1] No change in acreage, production, or net return in C zone. "All land" includes C zone.

TABLE 70.--Red River Backwater Area--New Orleans District: Estimated future crop acreage, crop production, and net return without and with project development

Crop	Without project			With project			Difference in net return	Percentage increase in net return
	Acres	Production[1]	Net return	Acres	Production[1]	Net return		
	100 acres	*1,000 units*	*1,000 dollars*	*100 acres*	*1,000 units*	*1,000 dollars*	*1,000 dollars*	*Percent*
Cotton...............	43	4	95	45	5	135	40	43
Corn.................	99	432	293	156	791	570	277	94
Soybeans.............	55	156	213	134	453	641	428	201
Oats.................	33	159	49	91	504	170	121	243
Oats pasture.........	[2] (17)	377	34	(51)	1,322	120	86	253
Permanent pasture....	81	2,111	194	151	4,972	467	273	140
Idle.................	4			5				
Other................	35			65				
Woodland.............	1,968		398	1,671		338	-60	-15
Total...........	2,318		1,276	2,318		2,441	1,165	91

[1] Cotton--500-pound bales; corn, soybeans, oats, and grain sorghum--bushels; rice--hundredweights; beef--pounds.
[2] Duplicated acreage.

TABLE 71.--New Orleans Engineer District of the Red River Backwater Area: Project summary

Item	Amount
Drainage operations:	
Woodland converted to open	*Acres*
cropland	29,700
Farmland drained	37,700
Associated costs:	
Initial:	*Dollars*
Woodland conversion	1,820,100
Farm drainage installations	609,000
Group drainage installations	197,700
Total associated costs	2,626,800
Annual equivalent:	
Conversion	99,700
Farm drainage	78,900
Group drainage	22,200
Annual farm drainage maintenance	60,700
Total annual costs	261,500
Annual increase in net farm income	1,164,600
Discounted value of:	
Annual increase in net farm income	816,000
Annual associated costs	261,000
Unadjusted benefits	555,000

Red River Backwater Protection Project--Vicksburg District

The Red River Backwater Protection in the Vicksburg District (fig. 29) includes the following:

1. A loop levee in the Ouachita-Lafourche area extending from the eastern edge of Monroe, La., to the west bank of Bayou Lafourche, thence down the west bank of Bayou Lafourche and Boeuf River to the vicinity of Horseshoe Lake, looping back up the east bank of the Ouachita River to tie with the terminus of the existing Ouachita River levee. Interior drainage would be provided by construction of an intercepting ditch parallel to the levee along Bayou Lafourche and Boeuf River to a connection with a floodgate in Grassy Lake. A sump would be provided above the Grassy Lake outlet for storage of excess runoff.
2. A levee in the Bushley Creek area along the right bank of Ouachita River from Harrisonburg, La., south to Little River, and along the north bank of Little River to the hill line near Rhinehart, La. Water from interior drainage would be evacuated through a floodgate in Bushley Creek. A sump would be provided above the Bushley Creek outlet for storage of excess runoff.
3. Improvement for the area below Sicily Island, La., that would protect an area south of Sicily Island by construction of a levee extending south from the southwestern edge of the Sicily Island Hills along the east bank of Ouachita River, up the right bank of Tensas River to a point opposite Sicily Island, and a tie to the Sicily Island ridge immediately above the town of Sicily Island. Interior drainage would be effected through natural streams improved as necessary to a connection with a floodgate in the southwestern part of the area. A sump for storage of excess runoff would be provided in the southwestern part of the area.
4. The Tensas-Cocodrie pumping plant, designed to reduce the sump area within the existing Tensas-Cocodrie ring levee.

Contained within the Vicksburg District part of the Red River Backwater Protection Project are 300,000 acres of fine-textured, very slowly permeable, poorly drained bottom-land soils which are difficult to drain and manage. Free from any flood hazard are 15,500 acres in the zone above the contour of the flood of record; 178,900 acres are subject to flooding, which would be alleviated by construction of the proposed project works; and 105,600 acres would not benefit from drainage but would remain as undrained land in the sump area.

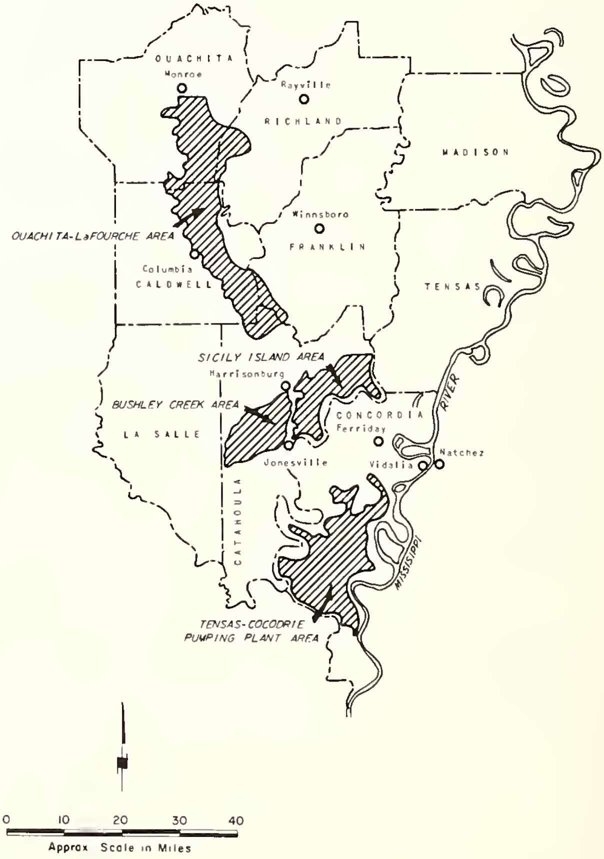


Figure 29.--Project area location, Red River Backwater Area, Vicksburg Corps of Engineers District.

A total of 13,100 acres is composed of moderately fine-textured, somewhat poorly drained soils of the bottom lands. These soils are moderately difficult to drain and manage but properly drained and managed produce high yields. They occupy 2,700 acres in the zone that is free from any flood hazard; 8,800 acres in the zone subject to flooding, which would be protected by the project; and 1,600 acres, which after project construction would be a sump and therefore undrained.

Medium-textured, moderately well- and well-drained bottom-land soils cover about 29,700 acres. Of these soils, 10,400 acres lie within the zone free from flooding; 17,200 acres are subject to flooding but would be protected by the project; and 2,100 acres are in the area that would not benefit from drainage.

Medium and moderately fine-textured, poorly and somewhat poorly drained soils of bottom lands and terraces of tributary streams occupy 9,500 acres. Where flooding is not a problem and when properly drained and managed, these soils produce moderate to high yields of adapted crops. Of this land, 400 acres lie in the zone that is free from flood hazard; 3,400 acres are subject to flooding, which would be corrected by the project; and 5,700 acres remain as a sump.

Occupying loess terraces within the area are 5,500 acres. These soils are medium-textured, well and moderately well drained, and easily managed. Of the total area of these soils, 700 acres lie above the contour of the flood of record; and 4,800 acres are subject to some degree of flooding but would be protected by the proposed project.

Soils of medium texture, poorly and somewhat poorly drained, and having claypans and fragipans, occupy part of the loess terrace area. These soils cover 5,100 acres in the flood-free zone; 13,700 acres of the area are subject to flooding, which would be corrected by project construction; and 900 acres are in the undrained sump area.

The area has 10,700 acres of medium- and moderately coarse-textured, well-drained soils. Of this acreage, 9,100 acres are free from floods; 1,400 acres are subject to flooding which would be alleviated by the project; and 200 acres would remain as undrained land in the sump area.

It is expected that if adequate flood protection and drainage were provided in the Vicksburg Corps of Engineers District part of the Red River Backwater area, 84 percent of land in the A zone, 60 percent of all land in the B zone, and 1 percent of land in the C zone would be open land. Of the open land, it is anticipated that 93 percent in the A zone, 87 percent in the B zone, and none in the C zone would be drained with the project. Changes in major land use and in the percentage of open land drained, by soil units, as estimated by USDA to take place with project development, are shown in table 72.

Total agricultural production in the area is expected to increase 94 percent and net agricultural income 95 percent if adequate flood protection and drainage is provided. The changes in crop acreages, production, and net income expected by USDA to result from land development under these assumed conditions are presented in tables 73 and 74.

TABLE 72.--Red River Backwater Area - Vicksburg District: Major land use and drainage, present and estimated future without and with project, soil units and zones

Item	All land in zone			Percentage of zone in--						Percentage of open land drained[1]		
				Open land			Woodland					
	A	B	C	A	B	C	A	B	C	A	B	C
	100 acres	*100 acres*	*100 acres*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Soil unit 1:												
Present	155	1,789	1,056	30	5	0	70	95	100	27	19	0
Without project	155	1,789	1,056	35	10	0	65	90	100	31	23	0
With project	155	1,789	1,056	59	54	0	41	46	100	85	87	0
Soil unit 2:												
Present	26	88	16	97	42	3	3	58	97	28	8	0
Without project	26	88	16	98	50	3	2	50	97	41	22	0
With project	26	88	16	100	82	3	0	18	97	96	92	0
Soil unit 5:												
Present	104	172	21	99	76	25	1	24	75	41	13	0
Without project	104	172	21	100	86	25	0	14	75	95	79	0
With project	104	172	21	100	91	25	0	9	75	95	90	0
Soil unit 8:												
Present	4	34	57	71	15	3	29	85	97	0	9	0
Without project	4	34	57	92	44	3	8	56	97	92	88	0
With project	4	34	57	92	54	3	8	46	97	92	94	0

See footnote at end of table.

TABLE 72.--Red River Backwater Area - Vicksburg District: Major land use and drainage, present and estimated future without and with project, soil units and zones--Continued

Item	All land in zone			Percentage of zone in--						Percentage of open land drained[1]		
				Open land			Woodland					
	A	B	C	A	B	C	A	B	C	A	B	C
	100 acres	*100 acres*	*100 acres*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Soil unit 9:												
Present	7	48		82	82		18	18		3	11	
Without project	7	48		98	94		2	6		90	85	
With project	7	48		98	95		2	5		90	95	
Soil unit 10:												
Present	51	137	9	58	35	12	42	65	88	35	5	0
Without project	51	137	9	64	39	12	36	61	88	53	18	0
With project	51	137	9	90	66	12	10	34	88	85	80	0
Soil unit 11:												
Present	91	13	1	100	98	0	0	2	100	85	33	0
Without project	91	13	1	100	100	48	0	0	52	100	98	0
With project	91	13	1	100	100	48	0	0	52	100	99	0
All:												
Present	438	2,281	1,160	69	16	1	31	84	99	49	13	0
Without project	438	2,281	1,160	72	22	1	28	78	99	77	49	0
With project	438	2,281	1,160	84	60	1	16	40	99	93	87	0

[1] Includes naturally and artificially drained land.

TABLE 73.--Red River Backwater Area--Vicksburg District: Estimated effects of project development on cropping systems[1]

Crop	Percentage change in acreage			Percentage change in production			Percentage change in net return		
	A zone	B zone	All land	A zone	B zone	All land	A zone	B zone	All land
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Cotton	17	-7	-6	25	8	10	35	17	18
Corn	21	219	121	29	260	141	30	274	152
Soybeans	22	314	191	31	388	218	32	416	232
Oats	22	200	126	30	296	177	34	372	215
Oats pasture	32	315	197	35	420	242	34	401	234
Permanent pasture	11	148	94	21	268	169	18	185	109
Idle	-23	-86	-64						
Other	16	174	111						
Woodland	-43	-49	-30	-43	-49	-30	-34	-49	-30
All land	0	0	0	25	147	94	25	155	95

[1] No change in acreage, production, or net return in C zone. "All land" includes C zone

TABLE 74.--Red River Backwater Area--Vicksburg District: Estimated future crop acreages, crop production, and net return without and with project development

Crop	Without project			With project			Difference in net return	Percentage increase in net return
	Acres	Production[1]	Net return	Acres	Production[1]	Net return		
	100 acres	*1,000 units*	*1,000 dollars*	*100 acres*	*1,000 units*	*1,000 dollars*	*1,000 dollars*	*Percent*
Cotton	34	3	61	32	3.4	72	11	18
Corn	81	317	191	179	764	481	290	152
Soybeans	109	310	401	317	988	1,331	930	232
Oats	170	633	167	384	1,698	526	359	215
Oats pasture	[2](107)	1,967	177	(318)	6,622	591	414	234
Permanent pasture	339	7,285	583	659	19,510	1,220	637	109
Idle	14			5				
Other	82			174				
Woodland	3,050		917	2,129		644	-273	-30
Total	3,879		2,497	3,879		4,865	2,368	95

[1] Cotton--500-pound bales; corn, soybeans, oats, and grain sorghum--bushels; rice--hundredweights; beef--pounds.
[2] Duplicated acreage.

It is anticipated that 92,100 acres of woodland will be converted to open land and drained with the project. Expected to be drained are 94,700 acres of farmland (including the converted woodland) if the project works are constructed. The total associated cost of land development was estimated at $7,429,000, with the annual equivalent at $649,000 including the cost of annual drainage maintenance. As indicated in table 75, the discounted value of annual increase in net agricultural income is estimated at $1,370,000, and the discounted value of annual associated costs at $414,000.

TABLE 75.--Vicksburg Engineer District of the Red River Backwater Area: Project summary

Item	Amount
Drainage operations:	
Woodland converted to open cropland	*Acres* 92,100
Farmland drained	94,700
Associated costs:	
Initial:	*Dollars*
Woodland conversion	5,825,400
Farm drainage installations	1,456,500
Group drainage installations	146,700
Total associated costs	7,428,600
Annual equivalent:	
Conversion	319,100
Farm drainage	188,600
Group drainage	16,400
Annual farm drainage maintenance	124,900
Total annual costs	649,000
Annual increase in net farm income	2,367,900
Discounted value of:	
Annual increase in net farm income	1,370,000
Annual associated costs	414,000
Unadjusted benefits	956,000

Of the total Red River Backwater Protection Project (including both the New Orleans and Vicksburg District portions) 84 percent is in woods. The percentage of land in woods varies according to texture and drainage characteristics of the soils; it ranges from 96 percent on the heavy-textured, poorly drained soils to 2 percent on the medium to coarse-textured, well-drained soils.

Intercepted Drainage West of West Atchafalaya Basin Protection Levee

This project (fig. 30) is proposed to improve major outlets to relieve flooding and facilitate drainage by providing means of removing excess surface water more rapidly. It is proposed that in eastern Rapides and south central Avoyelles Parishes the Overton Red River Waterway Channel between lock 2 and weir 8 be increased in size and a low-loss flume-type structure with taintor gate be installed adjacent to lock 2 under the waterway. These improvements would permit an increased rate of outflow from the problem area with most excess waters disposed of via the Red River Backwater Area. On infrequent occasions, high Red River backwater stages might preclude relief in this way and the water would have to be disposed of by the existing system.

The project proposes also to extend the Bayou Boeuf-Cocodrie Diversion Channel. The existing Bayou Boeuf-Cocodrie Diversion Channel extends only to the confluence of Bayou Boeuf with Bayou Cocodrie, which unite to form Bayou Courtableau. The proposed project includes the

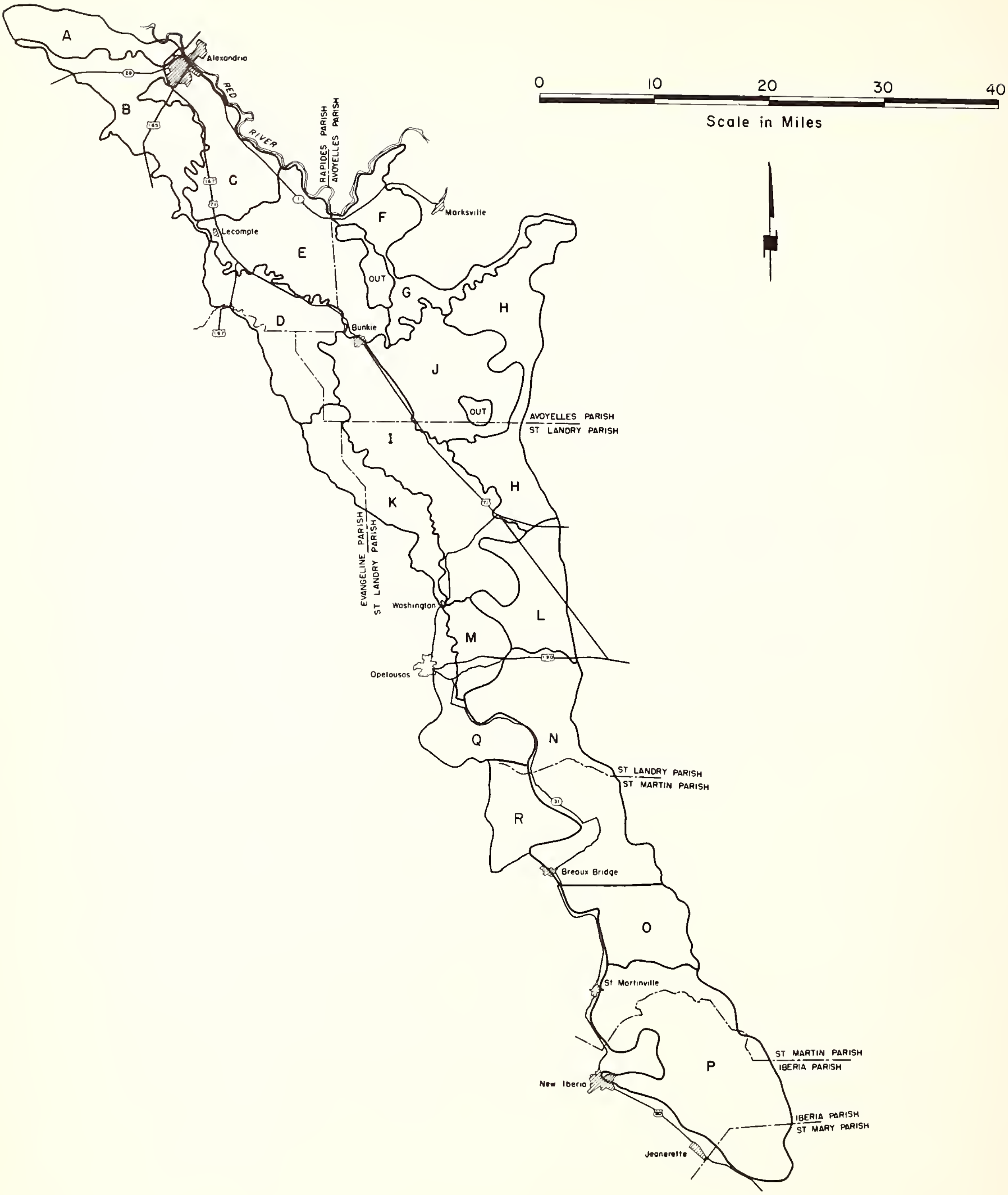


Figure 30.--Project area location, Intercepted Drainage West of West Atchafalaya Basin Protection Levee.

excavation of a cutoff about 3 miles long on Bayou Courtableau between its junctions with Bayous Wauksha and Boeuf, enlargement of Bayou Courtableau below Bayou Wauksha to Courtableau Weirs, and enlargement of the Bayou Courtableau drainage structure. The present Bayou Courtableau drainage structure consists of a five-barrel gated control structure through the West Atchafalaya Basin protection levee into the floodway. The project proposes construction of additional barrels.

The proposed project contains 539,700 acres, with 379,800 in the zone subject to flooding and overflow which would be alleviated by the project; and 157,900 acres in the zone that would remain undrained.

Of the 379,800 acres that would benefit from the project, 349,000 acres are heavy, fine- to moderately fine-textured soils which are slowly permeable and poorly drained to somewhat poorly drained bottom lands. Overflow hazards, lack of drainage outlets, and difficulty of management on these lands have held back development of this large area.

The remaining 30,800 acres that would benefit from project drainage are composed of 29,000 acres of bottom-land soils, which are medium-textured, moderately well and well drained, and fairly easy to manage. These soils are at somewhat higher elevations than the heavier-textured, hard-to-manage bottom-land soils. Of the total, 1,800 acres are loessial soils on islands of loessial terrace. Now in woodland are 383,600 acres, or 71 percent of the total land area.

It was estimated that if adequate flood protection and drainage were provided, 77 percent of all land in the B zone and 5 percent of all land in the C zone would be open land. Under assumptions of adequate flood protection and drainage, it was estimated that all open land in the B zone and none of the open land in the C zone would be drained. Changes in major land use and percentage of open land expected to be drained with project development as estimated by USDA are shown in table 76.

TABLE 76.--Intercepted drainage west of the West Atchafalaya: Major land use and drainage, present and estimated future without and with project, soil units and zones

Item	All land in zone			Percentage of zone in--						Percentage of open land drained[1]		
				Open land			Woodland					
	A	B	C	A	B	C	A	B	C	A	B	C
	100 acres	*100 acres*	*100 acres*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Soil unit 1:												
Present.................		3,197	1,579		26	5		74	95		13	0
Without project.........		3,197	1,579		29	5		71	95		24	0
With project............		3,197	1,579		73	5		27	95		100	0
Soil unit 2:												
Present.................		293	18		86	9		14	91		15	0
Without project.........		293	18		89	9		11	91		32	0
With project............		293	18		97	9		3	91		100	0
Soil unit 5:												
Present.................		290	2		91	90		9	10		6	0
Without project.........		290	2		94	90		6	10		33	0
With project............		290	2		99	90		1	10		100	0
Soil unit 8:												
Present.................		3			74			26			0	
Without project.........		3			81			19			0	
With project............		3			85			15			100	
Soil unit 9:												
Present.................		9			73			27			80	
Without project		9			95			5			100	
With project............		9			95			5			100	
Soil unit 10:												
Present.................		6			73			27			17	
Without project.........		6			77			23			51	
With project............		6			83			17			100	
All:												
Present.................		3,798	1,599		36	5		64	95		12	0
Without project.........		3,798	1,599		39	5		61	95		27	0
With project............		3,798	1,599		77	5		23	95		100	0

[1] Includes naturally and artificially drained land.

As indicated in tables 77 and 78, total agricultural production could be expected to increase 116 percent and net agricultural income 169 percent with adequate flood protection and drainage.

Woodland in the amount of 143,000 acres is expected to be converted and drained with project development. Including these converted woodlands, drainage is anticipated on 226,000 acres of farmland. The total associated costs of the land development were estimated by USDA at $18,059,000, with the annual equivalent at $1,561,000 including annual drainage maintenance cost.

As shown in table 79, the discounted value of annual increase in net farm income was estimated at $369,000 and the discounted value of annual associated costs at $104,000.

TABLE 77.--Intercepted drainage west of the West Atchafalaya: Estimated effects of project development on cropping systems[1]

Crop	Percentage change in acreage			Percentage change in production			Percentage change in net return		
	A zone	B zone	All land	A zone	B zone	All land	A zone	B zone	All land
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Cotton....................		-11	-11		22	22		89	89
Corn......................		85	85		154	154		190	190
Sugarcane.................		-22	-22		-14	-14		3	3
Soybeans..................		245	245		439	439		527	527
Oats......................		33	33		165	165		329	329
Oats pasture..............		64	64		239	239		220	220
Permanent pasture.........		89	89		531	531		245	222
Idle......................		0	0						
Other.....................		97	97						
Woodland..................		-62	-62					-62	-40
All land..............		0	0		132	116		194	169

[1] No change in acreage, production, or net return in C zone. "All land" includes C zone.

TABLE 78.--Intercepted drainage west of the West Atchafalaya: Estimated future crop acreages, crop production, and net return without and with project development

Crop	Without project			With project			Difference in net return	Percentage increase in net return
	Acres	Production[1]	Net return	Acres	Production[1]	Net return		
	100 acres	*1,000 units*	*1,000 dollars*	*100 acres*	*1,000 units*	*1,000 dollars*	*1,000 dollars*	*Percent*
Cotton..............	126	10.4	187	112	12.6	353	166	89
Corn................	379	1,431	908	701	3,629	2,635	1,727	190
Sugarcane...........	30	52	16	23	45	17	1	6
Soybeans............	196	416	520	675	2,243	3,262	2,742	527
Oats................	5	16	3	7	42	14	11	267
Oats pasture........	[2] (4)	45	4	(6)	154	14	10	250
Permanent pasture....	640	13,659	602	1,149	79,587	1,937	1,335	222
Idle................	30			30				
Other...............	155			299				
Woodland............	3,836		1,053	2,401		628	-425	-40
Total...........	5,397		3,293	5,397		8,860	5,567	169

[1] Cotton--500-pound bales; corn, soybeans, oats, and grain sorghum--bushels; rice--hundredweights; beef--pounds.
[2] Duplicated acreage.

TABLE 79.--Area of intercepted drainage west of the West Atchafalaya: Project summary

Item	Amount
Drainage operations:	
Woodland converted to open cropland	*Acres* 143,500
Farmland drained	226,000
Associated costs:	
Initial:	*Dollars*
Woodland conversion	14,303,200
Farm drainage installations	3,557,900
Group drainage installations	198,400
Total associated costs	18,059,500
Annual equivalent:	
Conversion	784,000
Farm drainage	444,800
Group drainage	22,200
Annual farm drainage maintenance	310,300
Total annual costs	1,561,300
Annual increase in net farm income	5,566,900
Discounted value of:	
Annual increase in net farm income	369,000
Annual associated costs	104,000
Unadjusted benefits	265,000

Lower Mississippi River and Tributaries Project in Louisiana

A total of 2,306,000 acres in Louisiana lie within the areas affected by proposed project works. About 522,600 acres lie above the contour of the flood of record and are not subject to flooding; about 1,233,000 acres are subject to flooding and overflow; and 550,400 acres are situated at too low an elevation to benefit from drainage. Within the project areas in Louisiana, 36 percent of all land in the A zone, 75 percent of all land in the B zone, and 96 percent of all land in the C zone are in timber. It was estimated by USDA that if adequate flood protection and drainage were provided, 83 percent of all land in the A zone, 59 percent of all land in the B zone, and 4 percent of all land in the C zone would be open land, leaving 17, 41, and 96 percent, respectively, in timber. The changes in major land use and in the percentage of land drained in each zone, by soil units, expected to occur with project development in Louisiana, are shown in table 80.

USDA estimated that total agricultural production could be increased 77 percent and net agricultural income 96 percent within the areas in Louisiana affected by the proposed project if full flood protection and adequate drainage were provided. The changes in crop acreages, production, and net agricultural income expected to occur with full land development are shown in tables 81 and 82.

It is anticipated that 463,900 acres of timber would be converted to open land, 449,200 acres of which would be drained. Including this drained converted woodland, 671,400 acres of farmland are expected to be drained. The total estimated associated cost of land development in the project areas in Louisiana is $56,937,000, the annual equivalent of which was estimated at $4,681,000, which would include the annual cost of drainage maintenance.

As shown in table 83, the discounted values of annual benefits and annual associated costs, attributable to the proposed project were estimated at $6,491,000 and $1,976,000, respectively.

TABLE 80.--Lower Mississippi River and Tributaries Project in Louisiana: Major land use and drainage, present and estimated future without and with project, soil units and zones

Item	All land in zone			Percentage of zone in--						Percentage of open land drained[1]		
				Open land			Woodland					
	A	B	C	A	B	C	A	B	C	A	B	C
	100 acres	*100 acres*	*100 acres*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Soil unit 1:												
Present	1,640	9,808	5,171	31	13	2	69	87	98	26	14	0
Without project	1,640	9,808	5,171	33	16	2	67	84	98	30	22	0
With project	1,640	9,808	5,171	62	52	2	38	48	98	87	90	0
Soil unit 2:												
Present	500	744	74	89	77	16	11	23	84	34	13	0
Without project	500	744	74	91	81	16	9	19	84	40	26	0
With project	500	744	74	99	94	16	1	6	84	94	95	0
Soil unit 5:												
Present	1,298	1,019	98	95	80	39	5	20	61	34	12	0
Without project	1,298	1,019	98	99	85	39	1	15	61	94	43	0
With project	1,298	1,019	98	99	96	39	1	4	61	97	94	0

See footnote at end of table.

TABLE 80.--Lower Mississippi River and Tributaries Project in Louisiana: Major land use and drainage, present and estimated future without and with project, soil units and zones--Continued

Item	All land in zone			Percentage of zone in-- Open land			Percentage of zone in-- Woodland			Percentage of open land drained[1]		
	A	B	C	A	B	C	A	B	C	A	B	C
	100 acres	*100 acres*	*100 acres*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Soil unit 8:												
Present.................	6	48	91	67	21	3	33	79	97	0	0	0
Without project.........	6	48	91	83	43	3	17	57	97	60	65	0
With project............	6	48	91	83	55	3	17	45	97	100	88	0
Soil unit 9:												
Present.................	220	97	6	95	81	50	5	19	50	8	16	0
Without project.........	220	97	6	98	92	50	2	8	50	38	65	0
With project............	220	97	6	99	96	50	1	4	50	92	96	0
Soil unit 10:												
Present.................	1,257	588	62	53	43	44	47	57	56	16	7	0
Without project.........	1,257	588	62	59	50	44	41	50	56	25	19	0
With project............	1,257	588	62	82	73	44	18	27	56	82	80	0
Soil unit 11:												
Present.................	303	19	2	99	95	50	1	5	50	51	26	0
Without project.........	303	19	2	100	100	50	0	0	50	99	75	0
With project............	303	19	2	100	100	50	0	0	50	99	95	0
Soil unit 12:												
Present.................	2			100			0			100		
Without project.........	2			100			0			100		
With project............	2			100			0			100		
Soil unit 13:												
Present.................		7			79			21			0	
Without project.........		7			92			8			100	
With project............		7			92			8			100	
All:												
Present.................	5,226	12,330	5,504	64	25	4	36	75	96	29	13	0
Without project.........	5,226	12,330	5,504	68	28	4	32	72	96	60	30	0
With project............	5,226	12,330	5,504	83	59	4	17	41	96	90	90	0

[1] Includes naturally and artificially drained land.

TABLE 81.--Lower Mississippi River and Tributaries Project in Louisiana: Estimated effects of project development on cropping systems[1]

Crop	Percentage change in acreage			Percentage change in production			Percentage change in net return		
	A zone	B zone	All land	A zone	B zone	All land	A zone	B zone	All land
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Cotton....................	-1	-1	-1	24	35	30	70	96	88
Corn	25	111	69	48	188	113	53	204	134
Sugarcane.................		-23	-23		-13	-13		6	6
Soybeans..................	35	249	125	55	394	179	58	450	200
Oats......................	34	187	78	5	228	72	67	367	146
Oats pasture..............	45	307	120	55	412	144	55	400	145
Permanent pasture.........	12	77	47	34	323	186	30	152	87
Idle......................	-25	-18	-21						
Other.....................	22	111	64						
Woodland..................	-48	-43	-29	-48	-44	-30	-40	-44	-29
All land.............	0	0	0	39	124	77	45	163	96

[1] No change in acreage, production, or net return in C zone. "All land" includes C zone.

TABLE 82.--Lower Mississippi River and Tributaries Project in Louisiana: Estimated future crop acreages, crop production, and net return without and with project development

Crop	Without project			With project			Difference in net return	Percentage increase in net return
	Acres	Production[1]	Net return	Acres	Production[1]	Net return		
	100 acres	*1,000 units*	*1,000 dollars*	*100 acres*	*1,000 units*	*1,000 dollars*	*1,000 dollars*	*Percent*
Cotton	582	43.4	586	574	56.0	1,104	518	88
Corn	1,304	4,899	2,891	2,203	10,435	6,775	3,884	134
Sugar cane	30	52	16	23	45	17	1	6
Soybeans	1,182	3,004	3,820	2,655	8,390	11,443	7,623	200
Oats	1,019	3,996	988	1,817	6,857	2,428	1,440	146
Oats pasture	[2] (513)	10,142	871	(1,131)	24,794	2,134	1,263	145
Permanent pasture	2,252	49,423	3,595	3,302	141,407	6,708	3,113	87
Idle	142			111				
Other	719			1,184				
Woodland	15,830		4,464	11,191		3,168	-1,296	-29
Total	23,060		17,231	23,060		33,777	16,546	96

[1] Cotton--500-pound bales; corn, soybeans, oats, and grain sorghum--bushels; rice--hundredweights; beef--pounds.
[2] Duplicated acreage.

TABLE 83.--Mississippi River and Tributaries Project Area in Louisiana: Project summary

Item	Amount	Item	Amount
Drainage operations:		Associated costs--Continued	
Woodland converted to open	*Acres*	Annual equivalent:	*Dollars*
cropland	463,900	Conversion	2,292,000
Farmland drained	671,400	Farm drainage	1,310,000
		Group drainage	64,000
		Annual farm drainage maintenance	1,015,000
Associated costs:		Total annual costs	4,681,000
Initial:	*Dollars*	Annual increase in net farm income	16,546,000
Woodland conversion	45,703,000	Discounted value of:	
Farm drainage installations	10,662,000	Annual increase in net farm income	6,491,000
Group drainage installations	572,000	Annual associated costs	1,976,000
Total associated costs	56,937,000	Unadjusted benefits	4,515,000

PROPOSED WATER-CONTROL PROJECTS IN MISSISSIPPI

Big Sunflower River Basin

The basin (fig. 31) comprises an area of some 4,100 square miles in northwestern Mississippi. The two major drainage outlets are Big Sunflower River with a drainage area of 3,100 square miles and Steele Bayou with a drainage area of 700 square miles. The proposed project modification involves channel improvements including enlargement, realignment, and clearing and snagging as necessary to provide improved major drainage outlets totaling about 663 miles in length.

Away from the natural levees and in some instances adjacent to the streams, the topography is more nearly level, and the soils are more poorly drained and heavier textured. Soil management is more difficult on these heavy soils, and thus the land use pattern changes. Grasses and legumes, small grains, and soy-

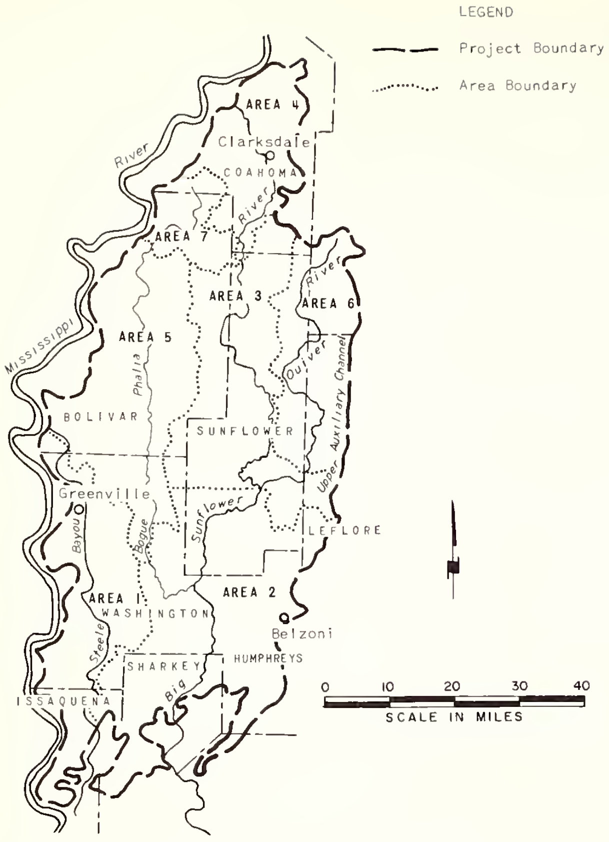


Figure 31.--Location map, Big Sunflower Project area, Mississippi.

beans occupy higher percentages of land. Only a small percentage is now planted to rice. Most of the present woodland is on the heavy soils.

Much of the area is subject to frequent flooding, mainly because of backwaters. Most of the low-lying, heavy clay soils and many of the depressional areas associated with the better-drained soils cannot be utilized properly because of poor drainage and the fact that floodwaters remain on the land until late spring. These conditions are due mainly to inadequate outlets for existing group-drainage facilities.

The Big Sunflower River Basin Project embraces 274,000 acres, of which 252,100 acres are in the zone subject to flooding which would benefit by construction of the proposed project works; and 21,900 acres are in the sump area which would not benefit from drainage.

A total of 79,300 acres lies in the upper part of the B zone,[24] and 172,800 acres lie in the lower part of the B zone.[25] Of the higher land, 70,600 acres, or 89 percent, are comprised of heavy, fine-textured, poorly drained clay soils difficult to manage. Of the total land area lying at the lower elevation, 159,200 acres, or 92 percent, are comprised of heavy, fine-textured, poorly drained, hard-to-manage soils.

At the upper elevation, an average of 68 percent of the land is in woodland, ranging from 72 percent on the heavier to 26 percent on the better drained lands. At the lower elevation, an average of 74 percent of the land is in woodland, ranging from 76 percent on the poorly drained to 24 percent on the better drained soils.

USDA estimated that with project development providing for adequate flood protection and drainage, 77 percent of all land in the B-1 zone, 72 percent of all land in the B-2 zone, and 16 percent of all land in the C zone would be open land; that 84 percent of all open land in Zone B-1, 82 percent of all open land in Zone B-2, and none of the open land in the C zone would be drained with the proposed project. USDA estimate of changes in major land use and in the percentage of open land drained, by soil units, are shown in table 84.

Assuming adequate flood protection and drainage outlets, USDA estimated that total agricultural production in the Big Sunflower River Basin could be increased 72 percent and net agricultural income 67 percent. Increases in production and net agricultural income are expected to result from changes in cropping patterns and in major land use, as indicated in tables 85 and 86.

As shown in table 87, 41,500 acres of woodland are expected to be converted to open land with project development. USDA anticipates that 58,200 acres of farmland (including the acreage of converted woodland participating in the project) would be drained if adequate flood protection and drainage outlets were provided. The total cost of land development associated with the proposed project development was estimated by USDA at $3,584,000, with the annual equivalent at $401,000 including annual cost of drainage maintenance. As indicated in table 87, the total value of annual increase in net agricultural income was estimated at $1,363,000. The discounted value of annual increase in net agricultural income, and the discounted value of annual associated costs were estimated by USDA at $511,000 and $226,000, respectively.

[24] This area was designated as Zone B-1.
[25] This area was designated as Zone B-2.

TABLE 84.--Big Sunflower River Basin: Major land use and drainage, present and estimated future without and with project, soil units and zones

Item	All land in zone			Percentage of zone in--						Percentage of open land drained[1]		
				Open land			Woodland					
	A	B	C	B-1	B-2	C	B-1	B-2	C	B-1	B-2	C
	100 acres	*100 acres*	*100 acres*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*
Soil unit 1:												
Present	684	1,568	145	52	50	19	48	50	81	28	24	0
Without project	684	1,568	145	59	55	22	41	45	78	41	38	0
With project	684	1,568	145	76	73	22	24	27	78	82	82	0
Soil unit 2:												
Present	22	24	1	80	74	100	20	26	0	46	43	0
Without project	22	24	1	83	79	100	17	21	0	59	55	0
With project	22	24	1	89	89	100	11	11	0	91	91	0
Soil unit 4:												
Present	8	9		64	75		36	25		74	69	
Without project	8	9		74	78		26	22		85	79	
With project	8	9		80	86		20	14		97	94	
Soil unit 5:												
Present	3	1		100	100		0	0		68	76	
Without project	3	1		100	100		0	0		78	85	
With project	3	1		100	100		0	0		91	97	
Soil unit 6:												
Present	68	86	5	86	74	11	14	26	89	48	40	0
Without project	68	86	5	88	78	18	12	22	82	63	52	0
With project	68	86	5	93	85	18	7	15	82	94	89	0
Soil unit 9:												
Present	1			100			0			67		
Without project	1			100			0			76		
With project	1			100			0			95		
Soil unit 14:												
Present	7	40	68	0	0	0	100	100	100	0	0	0
Without project	7	40	68	0	0	0	100	100	100	0	0	0
With project	7	40	68	0	0	0	100	100	100	0	0	0
All:												
Present	793	1,728	219	56	50	14	44	50	86	32	26	0
Without project	793	1,728	219	62	55	16	38	45	84	45	40	0
With project	793	1,728	219	77	72	16	23	28	84	84	82	0

[1] Includes naturally and artificially drained land.

TABLE 85.--Big Sunflower River Basin: Estimated effects of project development on cropping systems[1]

Crop	Percentage change in acreage			Percentage change in production			Percentage change in net return		
	A zone	B zone	All land	A zone	B zone	All land	A zone	B zone	All land
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Cotton....................		87	85		126	125		156	154
Corn......................		25			65	64		115	115
Soybeans..................		11			35			54	52
Oats......................		25			61	61		99	99
Oats pasture..............		53			91	91		81	81
Permanent pasture.........		36			75	72		72	69
Idle......................		-47	-45						
Other.....................		29	28						
Woodland..................		-38	-33		-38	-34		-38	-35
All land..............		0	0		74	72		70	67

[1] No change in acreage, production, or net return in C zone. "All land" includes C zone.

TABLE 86.--Big Sunflower River Basin: Estimated future crop acreages, crop production, and net return without and with project development

Crop	Without project			With project			Difference in net return	Percentage increase in net return
	Acres	Production[1]	Net return	Acres	Production[1]	Net return		
	100 acres	*1,000 units*	*1,000 dollars*	*100 acres*	*1,000 units*	*1,000 dollars*	*1,000 dollars*	*Percent*
Cotton.............	299	24.5	500	555	56.2	1,268	768	154
Corn...............	63	136	46	79	222	99	53	115
Soybeans...........	421	980	787	414	1,319	1,198	411	52
Oats...............	267	5	162	333	1,238	322	160	99
Oats pasture........	[2](0.6)	5	0.5	(0.8)	9	0.8	0.3	60
Permanent pasture...	212	3,790	150	286	6,528	253	103	69
Idle...............	67			36				
Other..............	148			189				
Woodland...........	1,263		381	848		249	132	-35
Total...........	2,740		2,027	2,740		3,390	1,363	67

[1] Cotton--500-pound bales; corn, soybeans, oats, and grain sorghum--bushels; rice--hundered-weights; beef--pounds.
[2] Duplicated acreage.

TABLE 87.--Big Sunflower River Basin: Project summary

Item	Amount
Drainage operations:	
Woodland converted to open cropland	*Acres* 41,500
Farmland drained	58,200
Associated costs:	
Initial:	*Dollars*
Woodland conversion	1,739,900
Farm drainage installations	1,000,000
Group drainage installations	845,000
Total associated costs	3,584,000
Annual equivalent	
Conversion	95,000
Farm drainage	131,000
Group drainage	63,000
Annual farm drainage maintenance	112,000
Total annual costs	401,800
Annual increase in net farm income	1,363,000
Discounted value of:	
Annual increase in net farm income	511,000
Annual associated costs	226,000
Unadjusted benefits	285,000

Yazoo Backwater Project

The Yazoo Backwater Project (fig. 32), which consists of 882,700 acres in the southern part of the Yazoo-Mississippi Delta, comprises portions of Washington, Humphreys, Yazoo, Issaquena, Sharkey, and Warren Counties in Mississippi. The Yazoo and Sunflower Rivers and Steele Bayou run through the area in a southerly direction. They would provide outlets for most of the group-drainage facilities within the proposed project. The lower Auxiliary Channel bisects the area from a point south of Silver City to its confluence with the Sunflower River south of Holly Bluff. Interceptive drainage ditches along the levee portion of the lower Auxiliary Channel would provide additional facilities for group drainage. In general, the upper limits of project effectiveness follow the 106.2 MSL contour, and the lower limits the 87-foot contour.

The proposed project involves construction of 53 miles of levees along the west bank of the Yazoo River from the lower end of the present east bank of the Mississippi River levee to near Yazoo City and 45 miles of levees along the east bank of the Yazoo River near Satartia, together with necessary pumping plants and floodgates to provide for intercepted drainage.

An area of 669,800 acres within the project consists of very slowly permeable, poorly drained soil on level to nearly level slopes. It occupies a lowland position between the natural levees of the major streams traversing the project area. Natural surface drainage is very slow. This soil is difficult to manage; when wet it is plastic, and when dry is subject to severe cracking which is injurious to the roots of certain plants. The inherent fertility of the soil is high; however, high yields of adapted crops are dependent upon excellent surface drainage and moderately dry years. About 76 percent of the project area is composed of this type of soil.

About 144,700 acres comprise soils that occupy an intermediate position between the natural levees and the backswamps. In general, these soils are poorly drained and somewhat difficult to manage until adequate farm and group drainage facilities are provided. Maximum yields and early plantings of adapted crops depend upon good surface drainage. About 16 percent of the project area is made up of this type of soil.

A total of 55,500 acres, or 6 percent, consists of better drained sandy loam and silt loam soils found along the natural levees of the larger streams and bayous. These soils are fairly well drained and well adapted to most crops grown in the area. Crop yields may be increased slightly with an adequate water-disposal system. Irrigation would materially increase the yields of cotton and corn on these soils.

About 2,000 acres, less than half of 1 percent, consist of soils that are excessively drained and occur only near old crevasses.

A total of 10,700 acres, or a little more than

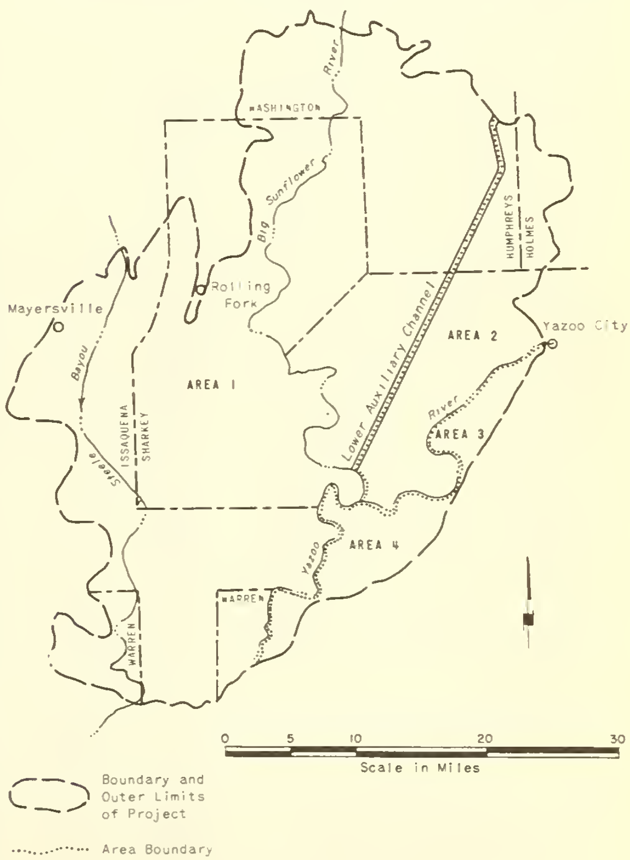


Figure 32.--Location map, Yazoo Backwater Project area, Mississippi.

1 percent is low swampy land. Although some of this land might be drained with a project, it is anticipated that most would remain in woods.

An average of 55 percent is in woods, ranging from 75 percent on the heavy, poorly drained lowlands to no woods on the excessively drained soils. The low swampy land is entirely in woods.

USDA estimated that with adequate flood protection and drainage, 71 percent of all land in the B zone and 10 percent of all land in the C zone would be open land. If adequate flood protection and drainage were provided by the proposed project, USDA would expect 82 percent of all open land in the B zone and none of the open land in the C zone to be drained. Changes in major land use and in percentage of open land drained estimated by USDA are shown in table 88.

TABLE 88.--Yazoo Backwater Area: Major land use and drainage, present and estimated future without and with project, soil units and zones

Item	All land in zone			Percentage of zone in--						Percentage of open land drained[1]		
				Open land			Woodland					
	A	B	C	A	B	C	A	B	C	A	B	C
	100 acres	*100 acres*	*100 acres*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Soil unit 1:												
Present		6,161	537		33	1		67	99		25	0
Without project		6,161	537		49	10		51	90		36	0
With project		6,161	537		64	10		36	90		75	0
Soil unit 2:												
Present		597	3		89	0		11	100		59	0
Without project		597	3		92	0		8	100		71	0
With project		597	3		95	0		5	100		96	0
Soil unit 3:												
Present		17			83			17			61	
Without project		17			87			13			80	
With project		17			91			9			92	
Soil unit 4:												
Present		242			94			6			79	
Without project		242			96			4			89	
With project		242			97			3			99	
Soil unit 5:												
Present		251			98			2			78	
Without project		251			99			1			91	
With project		251			99			1			99	
Soil unit 6:												
Present		827			83			17			69	
Without project		827			86			14			81	
With project		827			91			9			97	
Soil unit 7:												
Present		62				94		6			78	
Without project		62				96		4			87	
With project		62				99		1			98	
Soil unit 8:												
Present		20				67		33			44	
Without project		20				76		24			54	
With project		20				89		11			94	
Soil unit 11:												
Present		3			100			0			100	
Without project		3			100			0			100	
With project		3			100			0			100	
Soil unit 14:												
Present		81	26		0	0		100	100		0	0
Without project		81	26		0	0		100	100		0	0
With project		81	26		0	0		100	100		0	0
All:												
Present		8,261	566		46	1		54	99		45	0
Without project		8,261	566		59	10		41	90		53	0
With project		8,261	566		71	10		29	90		82	0

[1] Includes naturally and artificially drained land.

Assuming adequate flood protection and drainage, USDA estimated that total agricultural production could be increased 27 percent and net agricultural income 33 percent annually in the Yazoo Backwater Area. As indicated in tables 89 and 90, these increases would result in changes in cropping distribution and in major land use.

Under assumption of adequate flood protection and drainage provided by the project, USDA estimated that 102,000 acres of woodland would be converted to open cropland and drained. As shown in table 91, the total cost of land development associated with project construction was estimated by USDA to be $12,347,200, including annual cost of drainage maintenance, with the annual equivalent at $1,084,000. Total value of increase in annual net agricultural income was estimated at $3,843,300. The discounted value of increase in net agricultural income and of annual associated costs was estimated by USDA to be $2,079,000 and $1,243,000, respectively.

TABLE 89.--Yazoo Backwater Area: Estimated effects of project development on cropping systems[1]

Crop	Percentage change in acreage			Percentage change in production			Percentage change in net return		
	A zone	B zone	All land	A zone	B zone	All land	A zone	B zone	All land
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Cotton..................		15	15		26	26		33	33
Corn....................		17	17		31	31		31	31
Soybeans................		12	12		29	29		34	34
Oats....................		1	1		13	13		28	28
Oats pasture............		6	6		15	15		13	10
Permanent pasture........		56	54		77	75		81	78
Idle....................		21	21						
Other...................		21	21						
Woodland................		-30	-26					-29	-26
All land............		0	0		27	27		34	33

[1] No change in acreage, production, or net return in C zone. "All land" includes C zone.

TABLE 90.--Yazoo Backwater Area: Estimated future crop acreages, crop production, and net return without and with project development

Crop	Without project			With project			Difference in net return	Percentage increase in net return
	Acres	Production[1]	Net return	Acres	Production[1]	Net return		
	100 acres	*1,000 units*	*1,000 dollars*	*100 acres*	*1,000 units*	*1,000 dollars*	*1,000 dollars*	*Percent*
Cotton..............	1,247	143	4,411	1,431	179	5,870	1,459	33
Corn................	315	1,389	719	367	1,821	940	221	31
Soybeans............	910	2,402	2,431	1,021	3,106	3,256	825	34
Oats................	833	2,852	673	839	3,234	860	187	28
Oats pasture........	[2] (27)	311	29	(29)	356	32	3	10
Permanent pasture...	1,006	26,898	1,936	1,551	47,130	3,452	1,516	78
Idle................	98			118				
Other...............	490			592				
Woodland............	3,928		1,438	2,908		1,070	-368	-26
Total..........	8,827		11,637	8,827		15,480	3,843	33

[1] Cotton--500-pound bales; corn, soybeans, oats, and grain sorghum--bushels; rice--hundredweights; beef--pounds.
[2] Duplicated acreage.

TABLE 91.--Yazoo Backwater Area: Project summary

Item	Amount
Drainage operations:	
Woodland converted to open	*Acres*
cropland......................	102,000
Farmland drained................	120,200
Associated costs:	
Initial:	*Dollars*
Woodland conversion...........	8,887,000
Farm drainage installations....	2,008,000
Group drainage installations...	1,452,000
Total associated costs.......	12,347,000
Annual equivalent:	
Conversion....................	487,000
Farm drainage.................	213,000
Group drainage................	161,000
Annual farm drainage maintenance.	223,000
Total annual costs..........	1,084,000
Annual increase in net farm income.	3,843,000
Discounted value of:	
Annual increase in net farm	
income........................	2,079,000
Annual associated costs..........	1,243,000
Unadjusted benefits..........	836,000

Yazoo Headwater Project

The Yazoo Headwater drainage area is that portion of the Yazoo River watershed above the latitude of Yazoo City, Miss., comprising about 2,300 square miles in the alluvial valley and 6,600 square miles of hill lands (fig. 33). The Yazoo, Tallahatchie, and Coldwater Rivers form the main stem of the drainage system. The principal hill tributaries are the Little Tallahatchie, Yocona, and Yalobusha Rivers, and the principal delta tributaries are Cassidy Bayou and Tchula Lake. The main features of the project plan include four reservoirs on the principal hill tributaries, channel improvements, levees, and auxiliary channels along the main stem and tributaries, a hillside floodway, and local protection works for Greenwood, Belzoni, and Yazoo City.

Studies were made in seven subareas comprising 564,000 acres.

The four flood-control reservoirs have been constructed and local protection is complete for Yazoo City and partially completed for Greenwood. Channel improvement has been completed on the Coldwater, Yacona, Little Tallahatchie, and Yalobusha Rivers, and Bobo Bayou and Arkabutla Canal. The improvement of the Yazoo and Tallahatchie Rivers is complete except for construction of two cutoffs on each stream. Considerable work has been done on Cassidy Bayou. Only a small amount of levee construction has been constructed to date. Construction of the lower Auxiliary is underway.

Hillside Floodway Area (fig. 33) lies in southern Carroll and Laflore Counties and western Holmes County and between the Bluff Hills on the east and the Yazoo River on the west.

Before the four flood-control reservoirs in the headwaters of the Yazoo River system were completed, portions of the Hillside Floodway Area were subject to frequent flooding from backwater. At the same time, floodwaters and sediment were discharged into the area from the bluff tributaries. Much of the low-lying heavy clay soils and depressional areas associated with the better drained soils could not be utilized properly as floodwaters remained on the land until late spring or early summer. The better-drained lands were affected as proper drainage did not occur; planting of desired crops was delayed; and areas were isolated until floodwater receded.

Existing works of improvement consist of channel improvement in the main stem of the Yazoo River. Local drainage districts have tried to confine the flow of tributary streams in the Delta by channel improvement and levees constructed of local material. This has not been satisfactory, as the channels have filled with sand and the levees break frequently.

The proposed Hillside Floodway would intercept and divert flows from Abiaca, Chicopa, Fannegusha, and Black Creeks to the Yazoo River near Eden, Miss. Flows from the hill watersheds of these streams would be confined to a floodway formed by the hills on the east

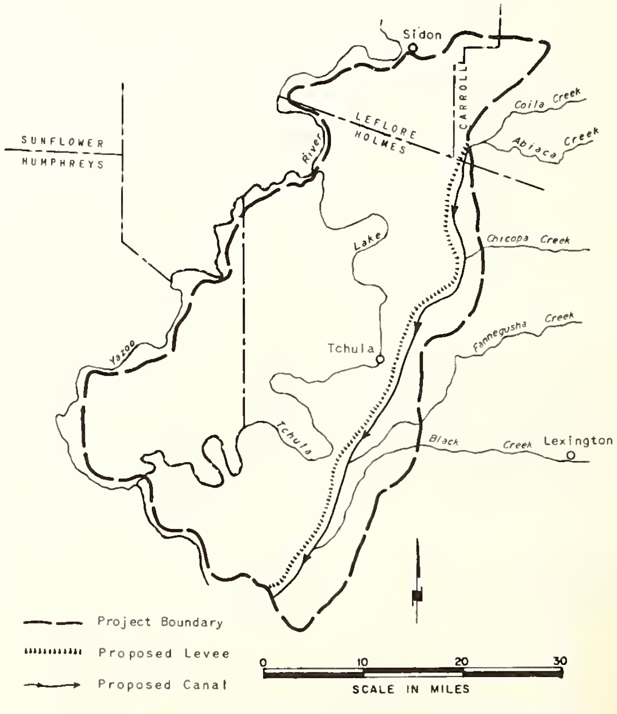


Figure 33.--Location map, Yazoo Headwater Project area, Hillside Floodway Area, Mississippi.

and a levee on the west. The levee would tie to the hills on the north side of Abiaca Creek and would extend southerly and generally parallel to the hill line, to a junction with the east-bank levee of Yazoo River near the mouth of Techeva Creek. A pilot channel would be provided for low-water flows in the floodway.

within the zone above the contour of the flood of record, which is free from flood hazard, 24 percent of the area has practically level topography. The soils in this area are very poorly drained, heavy clay. In this zone, 41 percent is practically level on gentle slopes. The soils are somewhat poorly drained silt loam and clay loams. Of the remaining land in this zone, 34 percent has gently sloping topography with well-drained, sandy loam soils. The other 1 percent is swamp.

Within the zone between the contour of the flood of record and the undrained sump area, 73 percent has practically level topography with heavy clay, very poorly drained soils. Most of these soils are subject to occasional overflow from the Yazoo River or the Bluff tributaries.

Pelucia Creek Area (fig. 34) lies in Carroll and Leflore Counties between the Bluff Hills on the east and the Yazoo River on the west. Most of the problems in this area are related directly to the characteristics of the upland portion of the watershed. Steep slopes, adverse hydrologic conditions, poor cover, and somewhat impervious soils are conducive to high runoff. The loess soils are extremely erosive, and in many places, gullies have penetrated into the underlying coastal-plain material. High runoff, plus erosive soil conditions, has caused considerable floodwater and sediment damage in the alluvial flood plain. Even though the floodway

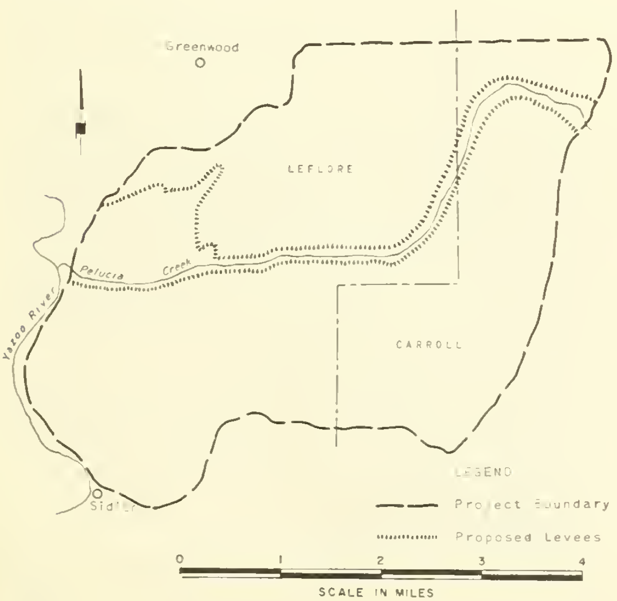


Figure 34.--Location map, Pelucia Creek area, Yazoo Headwater Project, Mississippi.

is leveed, there are storms of sufficient magnitude to cause frequent failures of the levee system.

The risk of damage to land from levee failures has resulted in an inadequate farm and group drainage system for lands near the floodway. The level of management employed and the status of development within this area are not equal to similar areas with full protection.

The existing works of improvement within the area consist of channel improvement from the confluence of Pelucia Creek and the Yazoo River to a point about 3 miles up Pelucia Creek. The Pelucia Drainage District has constructed a leveed floodway to the upstream point of the present works of improvement.

The proposed project would enlarge the existing floodway along the present alignment of Pelucia Creek. The south levee would be extended along the south bank of Pelucia Creek to a junction with the Yazoo River levee.

Within the zone above the contour of the flood of record, 10 percent of the land is practically level, with heavy clay soils that are very poorly drained; 56 percent has nearly level to gently sloping topography with somewhat poorly drained silt loam and clay loam soils; 30 percent is nearly level to gently sloping with well-drained silt loam and sandy loam soils; 2 percent comprises permeable, excessively drained sands; and an additional 2 percent is in swamp.

Within the zone between the contour of the flood of record and the undrained sump zone, 23 percent is nearly level with very poorly drained heavy clay soils; 36 percent has somewhat poorly drained silt loam and clay loam soils on nearly level to gently sloping terrain; 25 percent is nearly level to gently sloping with well-drained silt loam and sandy loam soils; and 16 percent is in swamp.

Big Sand Creek Area (fig. 35) lies in Carroll and Leflore Counties between the Yalobusha and Yazoo Rivers on the west and the Bluff Hills on the east. The problems in this area are the same as those existing in the Pelucia Creek Area and are directly related to the characteristics of the upland part of the watershed.

There are no works of improvement within the area. The Big Sand Drainage District confines the flow to a leveed floodway to a point near the Greenwood protection levee.

The proposed project consists of construction of a floodway along the alignment of the present channel from the Bluff Hills to the downstream end of the existing desilting basin and along a new alignment west to its point of entry intc the Yazoo River.

Within the zone above the contour of the flood of record, 59 percent of the soils are somewhat poorly drained and occur on nearly level to gently sloping terrain; the remaining 41 percent are well-drained silt loam soils and occur on nearly level topography.

Within the zone between the contour of the flood of record and the undrained sump area,

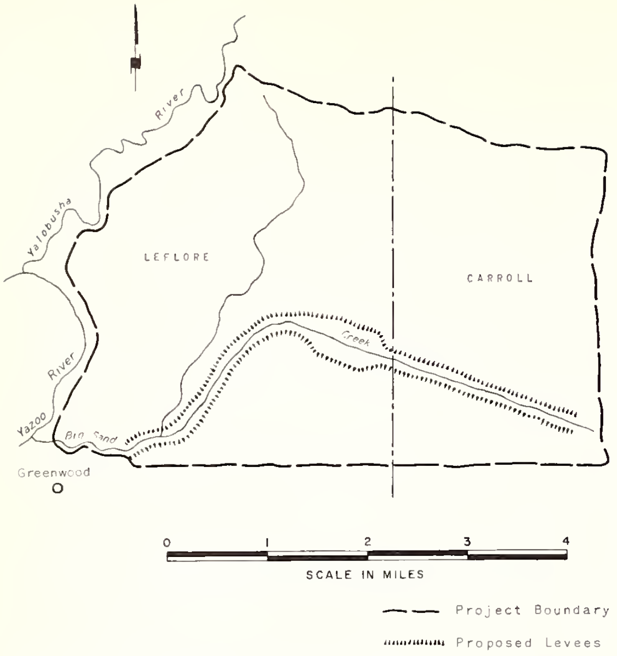


Figure 35.--Location map, Big Sand Creek area, Yazoo Headwater Project, Mississippi.

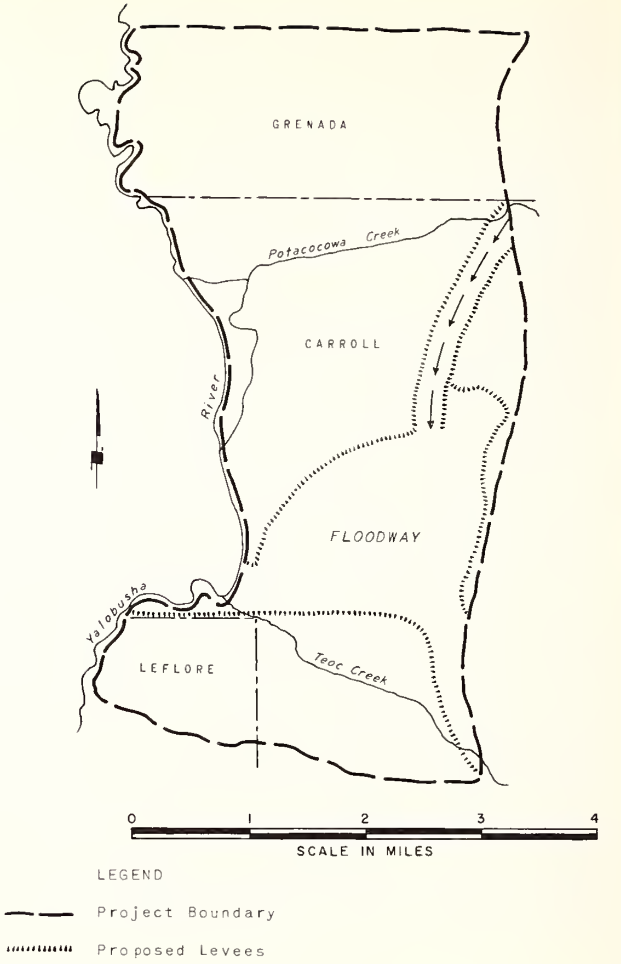


Figure 36.--Location map, Potacocowa-Teoc Creeks Area, Yazoo Headwater Project, Mississippi.

soil characteristics vary widely. About 18 percent of the soils are very poorly drained heavy clays on nearly level slopes; 61 percent are somewhat poorly drained silt loams and clay loams on nearly level slopes; 15 percent are well-drained silt loams on nearly level slopes, and 6 percent of the soils are sand deposits resulting from levee failure.

Potacocowa and Teoc Creeks (fig. 36) lie in Carroll County and lie between the Bluff Hills on the east and the Yalobusha River on the west. The problems in this project area are the same as those in the Pelucia Creek and Big Sand Creek Areas, and are related directly to the characteristics of the upland part of the watershed.

About 70 percent of the soils in the flood-free zone occupies nearly level to gentle slopes. They are well-drained silt loams. The remaining 30 percent are somewhat poorly drained silt loams on level terrain.

Soils in the zone between the flood-free zone and the sump area vary widely. About 14 percent are very poorly drained clays subject to overflow on nearly level to flat topography. About 65 percent are somewhat poorly drained silt loam and clay loam on level to gentle slopes. Nine percent are well-drained silt loams on nearly level slopes, and 11 percent are composed of sand deposits. About 1 percent of this zone is swamp.

No improvements have been made in this part of the project area. Local drainage districts have attempted to confine the flow of these streams within a leveed floodway.

The proposed project plans to divert Potacocowa and Teoc Creeks from their present locations to a common desilting basin in the low-lying wooded area east of Whaley, Miss. The proposed project would provide protection to the zone, which is now subject to flooding and sedimentation originating in the upland portion of the watershed. It would also provide adequate outlets for farm and group drainage systems, make it possible to raise the level of management, and extend development of woodlands for row crops and pasture. At present, 61 percent of this area is open land and the rest is wooded.

Swan Lake Area (fig. 37) lies in the southern part of Quitman County and the northern part of Tallahatchie County, between the loessial bluff on the east and Cassidy Bayou on the west. The Tallahatchie River runs through the area in a southerly direction and provides outlets for group-drainage facilities.

Within the zone subject to flooding and overflow, about 46 percent of the land is level with very poorly drained heavy clay soils. Thirty-two percent of the area is gently sloping, having somewhat poorly drained silt loam and clay loam soils; 18 percent is gently sloping with

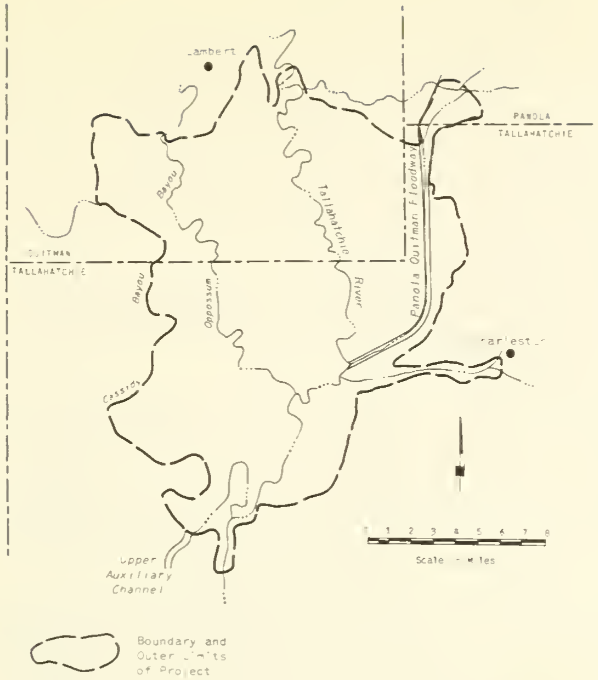


Figure 37.--Location map, Swan Lake Area, Yazoo Headwater Project, Mississippi.

well-drained sandy loam soils; and 4 percent is swamp.

Before completion of major works of improvement by the Corps which included construction of Arkabutla, Sardis, and Enid Reservoirs, channel improvement, levees, and so on, frequent flooding occurred in the area. Some of the land was abandoned and part of the low-lying heavy clay soils could not be utilized. This condition affected the better-drained lands by not providing proper drainage, delaying planting, and isolating areas until the floodwaters receded.

Existing works of improvement consist of channel improvement and realignment on the Tallahatchie, Coldwater, and Yocona Rivers. The Panola-Quitman overflow canal was constructed and now carries the Tallahatchie and Yocona Rivers. Levees have been constructed on the Panola-Quitman Floodway and on Tilltobia Creek. Channel-improvement work, consisting of clearing and snagging, has been completed on Cassidy Bayou. Drainage districts have constructed more than 50 percent of the group-drainage facilities required to drain the area adequately with the proposed project.

The proposed project involves installation of a new high-water diversion known as the upper Auxiliary Channel. The diversion would begin at Chute bridge near Swan Lake and join the Yazoo River about 15 miles northeast of Belzoni near the village of Famosla. Also involved is the development of drainage facilities, which would include channel cleanout of O'Possum Bayou; channel enlargement of Newsome Drainage Ditch 2; and channel improvement of Muddy and Hurricane Bayous. Gaps in the present levee system east and north of Tallahatchie River in the vicinity of Swan Lake would be closed so that all flows would go through the Tallahatchie River or the upper Auxiliary Channel.

About 51 percent of the Swan Lake Area is open land, 47 percent is woodland, and 2 percent is watered.

White Oak Bayou (fig. 38) is located in Tunica County with a small portion in northern Coahoma and Quitman Counties. The area is west of the existing west-bank levee of Coldwater River and Pompey Ditch.

Lack of major drainage outlets is the greatest problem in the area. This is reflected in low yields of cotton, soybeans, and corn. Crops are frequently lost or damaged because of ponding of local water. Planting dates are delayed in the spring because of inadequate farm drainage systems to remove surface waters resulting from winter and spring rains.

There are no works of improvement within the area. Local drainage districts have functioned for several years in an effort to improve the drainage in the southern part of Tunica County.

The proposed project consists of 54 miles of channel improvement in old Coldwater River,

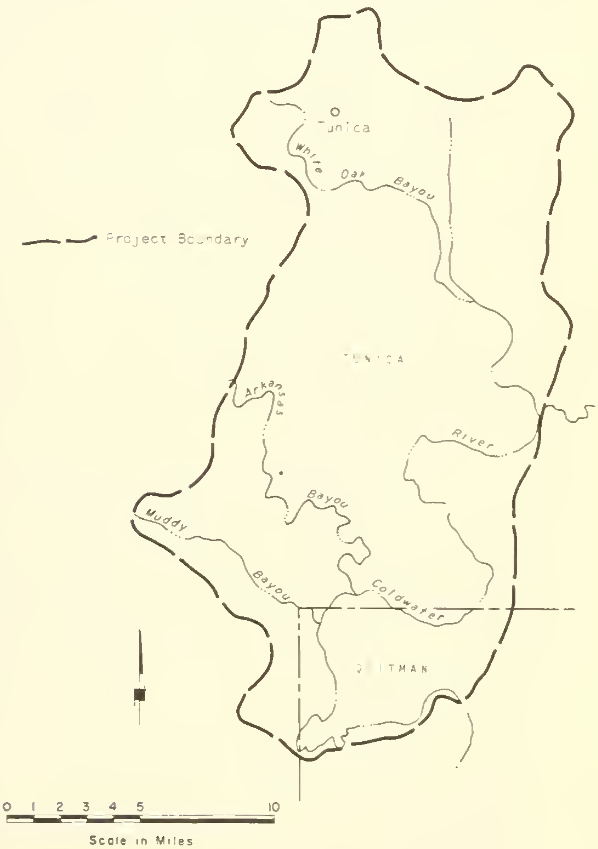


Figure 38.--Location map, White Oak Bayou Area, Yazoo Headwater Project, Mississippi.

Brushy Bayou, Walnut Lake, and White Oak Bayous. This improvement would start at Old Coldwater River at the head of the diversion to Cassidy Bayou and extend to the head of White Oak Bayou about a mile west of Tunica, Miss. The project would afford protection from floodwater damage which so frequently occurs in the zone subject to flooding.

Within the flood-free zone, about 62 percent of the soils are very poorly drained heavy clays; 25 percent are somewhat poorly drained silt loams and clay loams occupying gentle slopes; and 13 percent are well-drained sandy loams on nearly level slopes.

Within the zone subject to flooding, about 82 percent of the soils are very poorly drained heavy clays occurring on nearly level to gentle slopes. Fifteen percent of the soils in this zone are somewhat poorly drained silt loams and clay loams on nearly level slopes; and 3 percent are well-drained sandy loams on gentle slopes.

About 63 percent of the White Oak Bayou area is open land, 36 percent is woodland, and 1 percent is urban and watered area.

McKinney Bayou (fig. 39) lies in the northwestern part of Tunica County. The southernmost portion of the project is about 3 miles due west of the town of Tunica, Miss. The east bank of the Mississippi River levee forms the western boundary of the project area, while the eastern boundary follows largely the Yazoo and Mississippi Valley Railroad.

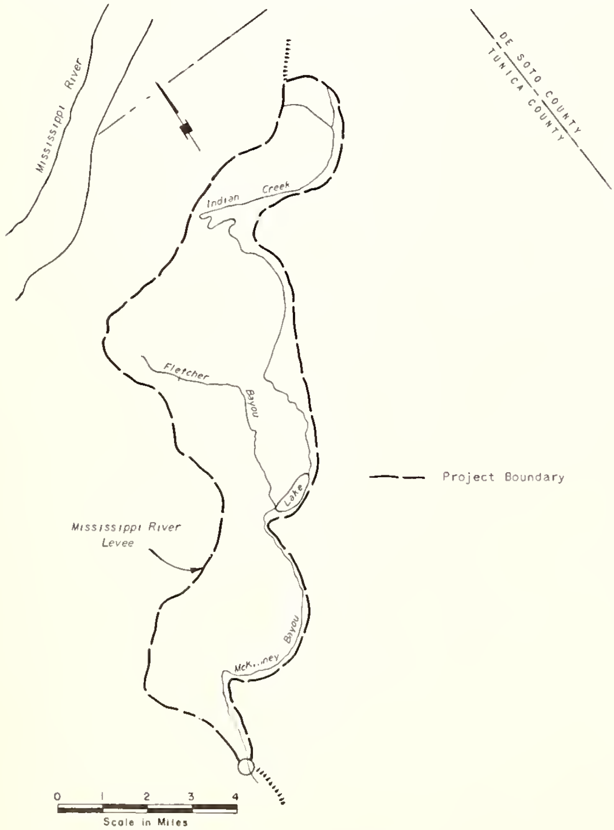


Figure 39.--Location map, McKinney Bayou Area, Yazoo Headwater Project, Mississippi.

Drainage for the area depends upon the existing pumping plant located where McKinney Bayou makes contact with the Mississippi River levee. The capacity of this plant has not been sufficient to provide adequate farm drainage for the area. As a result, land within the zone subject to flooding has not been utilized to the extent it could have been with better protection. Flooding of cropland and delayed planting of crops are the major problems.

The proposed project would provide for replacement of the present pumping plant with a new plant having a capacity of 300 cubic feet per second.

Within the zone free from flood hazard in this area, about 17 percent of the soils are very poorly drained heavy clays occupying level to nearly level topography; 42 percent are moderately well-drained clay loam soils on gentle slopes; 40 percent are well-drained sandy loams on nearly level to gentle slopes; and 1 percent of the soils are excessively drained.

Within the zone between the contour of the flood of record and the permanently wet sump area, 61 percent of the soils are very poorly drained heavy clays on level terrain; 29 percent are moderately well-drained clay loam soils on gentle slopes; and 10 percent are well-drained sandy loams on nearly level slopes.

About 80 percent of this area is open land, 19 percent is woodland, and 1 percent is watered area.

USDA anticipated that if adequate flood protection and drainage were provided by the proposed Yazoo Headwater Project, 90 percent of all land in the A zone, 72 percent of all land in the B zone, and 39 percent of all land in the C zone would be open land. It was estimated by USDA, that with the assumed conditions, 90 percent of all open land in the A zone, 89 percent of all open land in the B zone, and none of the open land in the C zone would be drained. The changes anticipated by USDA with project development as regards major land use and percentage of open land drained are shown in table 92.

If the proposed flood-control-drainage project were constructed and adequate flood protection and drainage outlets were provided, the USDA estimated that total agricultural production could be increased 24 percent and net annual agricultural income 29 percent. These increases would result from changes in major land use and changes in cropping distribution, as shown in tables 93 and 94.

It was estimated by USDA that 50,800 acres of woodland would be converted to open land, 30,600 acres of which would be drained. A total of 116,800 acres of farmland (including the drained converted woodland) is expected to be drained with assumed adequate flood protection and drainage. As indicated in table 95, the total associated cost of land development with project construction was estimated by USDA at

TABLE 92.--Yazoo Headwater Area: Major land use and drainage, present and estimated future without and with project, soil units and zones

Item	All land in zone			Percentage of zone in--						Percentage of open land drained[1]		
				Open land			Woodland					
	A	B	C	A	B	C	A	B	C	A	B	C
	100 acres	*100 acres*	*100 acres*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Soil unit 1:												
Present	950	1,494	421	64	30	13	36	70	87	32	36	0
Without project	950	1,494	421	72	46	41	28	54	59	46	48	0
With project	950	1,494	421	84	64	41	16	36	59	81	84	0
Soil unit 2:												
Present	98	8	1	93	85	62	7	15	38	55	38	0
Without project	98	8	1	95	87	62	5	13	38	74	62	0
With project	98	8	1	97	97	62	3	3	38	95	90	0
Soil unit 4:												
Present	494	211	10	93	88	29	7	12	71	74	78	0
Without project	494	211	10	94	90	43	6	10	57	94	92	0
With project	494	211	10	95	92	43	5	8	57	99	98	0
Soil unit 5:												
Present	57	1		99	100		1	0		68	54	
Without project	57	1		99	100		1	0		87	78	
With project	57	1		100	100		0	0		98	96	
Soil unit 6:												
Present	732	382	33	82	77	55	18	23	45	54	58	0
Without project	732	382	33	88	83	47	12	17	53	73	72	0
With project	732	382	33	94	90	47	6	10	53	92	94	0
Soil unit 7:												
Present	93	107	5	94	91	82	6	9	18	68	62	0
Without project	93	107	5	97	93	91	3	7	9	84	79	0
With project	93	107	5	97	96	91	3	4	9	97	95	0
Soil unit 8:												
Present	63	299	27	70	61	26	30	39	74	62	45	0
Without project	63	299	27	74	70	48	26	30	52	77	59	0
With project	63	299	27	84	81	48	16	19	52	90	88	0
Soil unit 12:												
Present	2			100			0			100		
Without project	2			100			0			100		
With project	2			100			0			100		
Soil unit 13:												
Present	4	33		73	52	16	27	48	84	100	100	0
Without project	4	33		73	52	39	27	48	61	100	100	0
With project	4	33		73	61	39	27	39	61	100	100	0
Soil unit 14:												
Present	16	56	43	0	0	0	100	100	100	0	0	0
Without project	16	56	43	0	0	0	100	100	100	0	0	0
With project	16	56	43	0	0	0	100	100	100	0	0	0
All:												
Present	2,509	2,591	540	78	48	16	22	52	84	53	52	0
Without project	2,509	2,591	540	83	59	39	17	41	61	70	63	0
With project	2,509	2,591	540	90	72	39	10	28	61	90	89	0

[1] Includes naturally and artificially drained land.

TABLE 93.--Yazoo Headwater Area: Estimated effects of project development on cropping systems[1]

Crop	Percentage change in acreage			Percentage change in production			Percentage change in net return		
	A zone	B zone	All land	A zone	B zone	All land	A zone	B zone	All land
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Cotton....................	11	26	17	21	39	27	27	53	37
Corn......................	3	8	5	14	28	18	15	44	28
Rice......................		15	11		27	19		109	75
Soybeans..................	5	23	5	16			17	54	28
Oats......................	7	24	11	18	39	24	24	49	29
Permanent pasture.........	7	23	15	18	48	32	16	53	32
Idle......................	7	7	7						
Other.....................	8	22	13						
Woodland..................	-39	-32	-28	-39	-32	-27	-26	-32	-24
All land.............	0	0	0	18	34	24	20	43	29

[1] No change in acreage, production, or net return in C zone. "All land" includes C zone.

TABLE 94.--Yazoo Headwater Area: Estimated future crop acreages, crop production, and net return without and with project development

Crop	Without project			With project			Difference in net return	Percentage increase in net return
	Acres	Production[1]	Net return	Acres	Production[1]	Net return		
	100 acres	*1,000 units*	*1,000 dollars*	*100 acres*	*1,000 units*	*1,000 dollars*	*1,000 dollars*	*Percent*
Cotton...............	1,411	149	4,037	1,650	189	5,532	1,495	37
Corn.................	291	996	447	304	1,181	570	123	28
Rice.................	41	108	8	45	129	14	6	75
Soybeans.............	689	2,063	1,912	764	2,564	2,450	538	28
Oats.................	471	1,755	458	523	2,147	593	135	29
Permanent pasture....	467	10,411	874	536	13,702	1,158	284	32
Idle.................	78			83				
Other................	383			434				
Woodland.............	1,809		676	1,301		513	-163	-24
Total...........	5,640		8,412	5,640		10,830	2,418	29

[1] Cotton--500-pound bales; corn, soybeans, oats, and grain sorghum--bushels; rice--hundredweights; beef--pounds.

TABLE 95.--Yazoo Headwater Area: Project summary

Item	Amount
Drainage operations:	
Woodland converted to open cropland........................	*Acres* 50,800
Farmland drained..................	116,800
Associated costs:	
Initial:	*Dollars*
Woodland conversion............	31,000
Farm drainage installations.....	1,944,000
Group drainage installations....	1,899,000
Total associated costs........	3,874,000
Annual equivalent:	
Conversion.....................	170,000
Farm drainage..................	252,000
Group drainage.................	212,000
Annual farm drainage maintenance..	229,000
Total annual costs............	863,000
Annual increase in net farm income..	2,418,000
Discounted value of:	
Annual increase in net farm income.........................	1,469,000
Annual associated costs..........	627,000
Unadjusted benefits............	842,000

$3,874,000, the annual equivalent at $863,000 including annual cost of drainage maintenance.

The discounted values of annual increase in net agricultural income and of annual associated costs were estimated to be $1,469,000 and $627,000, respectively.

Lower Mississippi River and Tributaries Project in Mississippi

Contained within the Lower Mississippi River and Tributaries Project in Mississippi are 1,720,700 acres. Of all land included within the project areas in the State, about 15 percent is within the A zone, above the contour of the flood of record; about 78 percent lies within the B zone and is subject to flooding to some degree; and about 7 percent of the land in the project areas lies within the C zone. At present, 22 percent of the land in the A zone, 52 percent in the B zone, and 91 percent in the C zone is in timber. Of all open land in the A zone, 53 percent is drained. Of all open land in the B zone, 43 percent is drained, and of the land in the C zone none is drained. USDA estimated that with adequate flood protection and drainage, 90 percent of all land in the A zone would be open land, of which 90 percent would be drained; 72 percent of all land in the B zone would be open land, of which 83 percent would be drained; and 23 percent of all land in the C zone would be open land, none of which would be drained. The changes in major land use and in the percentage of open land drained with project development, by soil units, as estimated by USDA, are shown in table 96.

USDA estimated that if adequate flood protection and drainage were provided within the Lower Mississippi River and Tributaries Project Areas in Mississippi, total agricultural production within the project areas could be increased 25 percent and net annual agricultural income 35 percent. These increases would result from estimated changes in major land use and in cropping distributions, as indicated in tables 97 and 98.

Assuming adequate flood protection and drainage, USDA estimated that 194,300 acres of woodland would be cleared with project development, of which 153,000 acres would participate in the drainage project. It was estimated that 295,200 acres of farmland including the converted woodland participating in the project would be drained. Total associated cost of land development within the project areas in Mississippi was estimated by the USDA at $19,805,000 with the annual equivalent, including annual cost of farm drainage maintenance, at $2,348,000.

TABLE 96.--Lower Mississippi River and Tributaries Project, Mississippi: Major land use and drainage, present and estimated future without and with project, soil units and zones

Item	All land in zone			Percentage of zone in--						Percentage of open land drained[1]		
				Open land			Woodland					
	A	B	C	A	B	C	A	B	C	A	B	C
	100 acres	*100 acres*	*100 acres*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Soil unit 1:												
Present...............	950	9,907	1,103	64	37	8	36	63	92	32	26	0
Without project.......	950	9,907	1,103	72	50	23	28	50	77	46	39	0
With project..........	950	9,907	1,103	84	78	23	16	22	77	81	78	0

See footnote at end of table.

TABLE 96.--Lower Mississippi River and Tributaries Project, Mississippi: Major land use and drainage, present and estimated future without and with project, soil units and zones--Continued

Item	All land in zone			Percentage of zone in--						Percentage of open land drained[1]		
				Open land			Woodland					
	A	B	C	A	B	C	A	B	C	A	B	C
	100 acres	100 acres	100 acres	Per-cent	Per-cent	Per-cent	Per-cent	Per-cent	Per-cent	Per-cent	Per-cent	Per-cent
Soil unit 2:												
Present...............	98	651	5	98	88	40	7	12	60	55	58	0
Without project.......	98	651	5	95	91	40	5	9	60	74	70	0
With project..........	98	651	5	97	95	40	3	5	60	95	96	0
Soil unit 3:												
Present...............		17			83			17			61	
Without project.......		17			87			13			80	
With project..........		17			91			9			92	
Soil unit 4:												
Present...............	494	470	10	93	91	30	7	9	70	74	78	0
Without project.......	494	470	10	94	93	40	6	7	60	94	90	0
With project..........	494	470	10	95	95	40	5	5	60	99	99	0
Soil unit 5:												
Present..............	57	256		99	98		1	2		68	78	
Without project.......	57	256		99	98		1	2		87	91	
With project..........	57	256		100	98		0	2		98	99	
Soil unit 6:												
Present...............	732	1,363	38	82	81	50	18	19	50	54	63	0
Without project.......	732	1,363	38	88	85	42	12	15	58	73	76	0
With project..........	732	1,363	38	94	91	42	6	9	58	92	95	0
Soil unit 7:												
Present...............	93	169	5	94	92	82	6	8	18	68	68	0
Without project.......	93	169	5	97	95	91	3	5	9	84	81	0
With project..........	93	169	5	97	98	91	3	2	9	97	96	0
Soil unit 8:												
Present...............	63	319	27	70	62	26	30	38	74	62	45	0
Without project.......	63	319	27	74	71	48	26	29	52	77	58	0
With project..........	63	319	27	84	82	48	16	18	52	90	89	0
Soil unit 9:												
Present...............		1			100			0			67	
Without project.......		1			100			0			76	
With project..........		1			100			0			95	
Soil unit 11:												
Present...............		3			100			0			100	
Without project.......		3			100			0			100	
With project..........		3			100			0			100	
Soil unit 12:												
Present...............	2			100			0			100		
Without project.......	2			100			0			100		
With project..........	2			100			0			100		
Soil unit 13:												
Present...............	4	33		73	52		27	48		100	100	
Without project.......	4	33		73	52		27	48		100	100	
With project..........	4	33		73	61		27	39		100	100	
Soil unit 14:												
Present...............	16	184	137	0	0	0	100	100	100	0	0	0
Without project.......	16	184	137	0	0	0	100	100	100	0	0	0
With project..........	16	184	137	0	0	0	100	100	100	0	0	0
All:												
Present...............	2,509	13,373	1,325	78	48	9	22	52	91	53	43	0
Without project.......	2,509	13,373	1,325	83	58	23	17	42	77	70	53	0
With project..........	2,509	13,373	1,325	90	72	23	10	28	77	90	83	0

[1] Includes naturally and artificially drained land.

TABLE 97.--Lower Mississippi River and Tributaries Project; Mississippi: Estimated future crop acreages, crop production, and net return without and with project development

Crop	Without project			With project			Difference in net return	Percentage increase in net return
	Acres	Production[1]	Net return	Acres	Production[1]	Net return		
	100 acres	*1,000 units*	*1,000 dollars*	*100 acres*	*1,000 units*	*1,000 dollars*	*1,000 dollars*	*Percent*
Cotton..............	2,957	316	8,948	3,636	424	12,670	3,722	42
Corn................	669	2,521	1,212	750	3,224	1,609	397	33
Rice................	41	108	8	45	129	14	6	75
Soybeans............	2,020	5,445	5,130	2,199	6,989	6,904	1,774	35
Oats................	1,571	4,612	1,293	1,695	6,619	1,775	482	37
Oats pasture.........	[2] (28)	316	30	(30)	365	33	3	10
Permanent pasture....	1,685	41,099	2,960	2,373	67,360	4,863	1,903	64
Idle................	243			237				
Other...............	1,021			1,215				
Woodland............	7,000		2,495	5,057		1,832	-663	-27
Total...........	17,207		22,076	17,207		29,700	7,624	35

[1] Cotton--500-pound bales; corn, soybeans, oats, and grain sorghum--bushels; rice--hundredweights; beef--pounds.
[2] Duplicated acreage.

TABLE 98.--Lower Mississippi River and Tributaries Project, Mississippi: Estimated future crop acreages, crop production, and net return without and with project development

Crop	Percentage change in acreage			Percentage change in production			Percentage change in net return		
	A zone	B zone	All land	A zone	B zone	All land	A zone	B zone	All land
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Cotton..................	11	28	23	21	39	34	27	47	42
Corn....................	3	16	12	14	33	28	15	37	33
Rice....................		14	10		26	19		100	75
Soybeans................	5	14	11	16	33	28	17	41	35
Oats....................	7	8	8	18	25	44	24	42	37
Oats pasture............		7	7		15	15		14	10
Permanent pasture........	7	48	41	18	92	64	16	75	64
Idle....................	7	-4	-2						
Other...................	8	23	19						
Woodland................	-39	-32	-28	-39	-32	-27	-26	-31	-27
All land............	0	0	0	18	35	25	20	40	35

[1] No change in acreage, production, or net return in C zone. "All land" includes C zone.

As shown in table 99, the annual increase in net agricultural income from project effects (assuming adequate flood protection and drainage) was estimated at $7,624,000. The discounted value of the estimated increase in net annual agricultural income and of estimated annual associated cost attributable to the project are $4,059,000 and $2,096,000, respectively.

TABLE 99.--Mississippi River and Tributaries Project Area in Mississippi: Project summary

Item	Amount	Item	Amount
Drainage operations:		Associated costs--Continued	
Woodland converted to open	*Acres*	Annual equivalent:	*Dollars*
cropland......................	194,300	Conversion....................	752,000
Farmland drained................	295,200	Farm drainage.................	596,000
		Group drainage................	436,000
		Annual farm drainage maintenance..	564,000
Associated costs:		Total annual costs...........	2,348,000
Initial:	*Dollars*	Annual increase in net farm income	7,624,000
Woodland conversion...........	10,657,000	Discounted value of:	
Farm drainage installations....	4,952,000	Annual increase in net farm income	4,059,000
Group drainage installations...	4,196,000	Annual associated costs..........	2,096,000
Total associated costs.......	19,805,000	Unadjusted benefits............	1,963,000

HILL-LAND PROBLEM AREAS IN MISSISSIPPI

Big Sand Creek

The upland portion of the Big Sand Creek watershed comprises about 75,500 acres. Big Sand Creek lies in Carroll and Montgomery Counties and flows in a westerly direction. Its watershed is 18 miles long east and west and 12 miles wide at its widest point. At its point of entry into the Delta, the watershed is about 4 miles wide. Above Carrollton, the watershed fans out in the typical dendritic pattern.

The upland portion of the watershed lies within the Loess Resource Area. From Carrollton westward, the loess soil is very deep and highly dissected with moderate erosion. East of Carrollton, the loess soil decreases in depth, dissection of the landscape lessens, but soil erosion is very severe. Large areas of land have been abandoned because of advanced stages of erosion; many large gullies have penetrated through the loess soil into the sands and clays of the underlying coastal-plain formation. The susceptibility of these soils to erosion has been a great factor in the tremendous amount of sediment deposited in the Delta. This source contributes materially to the total amount of sediment transported to the Delta. The valley bottoms are broad and most channels are deep and wide. Channel degrading is prominent in the tributaries and loss of land from streambank cutting is serious between Valley Hill and McCarley.

About 61 percent of the land in the upland watershed is in timber, 11 percent in pasture, 18 percent in cultivation, 9 percent is idle, and about 1 percent is in miscellaneous uses. Woodland and pasture soils are in poor physical condition, mainly because of poor management. Infiltration is slow and runoff is rapid. Valley slopes on the tributaries average about 25 feet per mile on the main-stem slopes, about 10 feet per mile in the corridor, and about 15 feet per mile above Carrollton. Average annual precipitation in the watershed is 52 inches.

The agricultural history of the area is one of rapid deterioration of natural resources, caused mainly by the unfavorable characteristics of the watershed. Much of the fertile hill farmlands have now ceased to produce except at near-subsistence levels or have been abandoned. Cultivation of row crops is confined largely to the bottoms and narrow ridge tops. The severely eroded hills have been retired to pastures or trees, or remain idle. On unprotected fields, sheet and gully erosion continues at a rapid rate. Shifting channels, fluctuating water levels, and high velocity tend to weaken the stability of unprotected streambanks, and erosion of the banks results in considerable loss of fertile bottom land. Once the soil material enters the deep-side channels, which are effective transport systems for sediment, much of it is carried to the Delta.

The Delta portion of the Big Sand Creek watershed comprises about 14,000 acres. The present channel of Big Sand Creek in the Delta follows its natural course to about 5,500 feet west of its entry into the Delta. At this point, the Big Sand Drainage District has constructed a channel and levee system to carry the hill waters directly to the Yazoo River.

Prior to any measures to confine or control the flow of water, the stream "wandered at will" after entering the alluvial flood plain. Recent soil surveys in the area have revealed strata of sand and silt at varying depths and thicknesses. For several miles west of the bluffs, soils have been influenced also by deposits of silt transported from this hill tributary.

Since the levees, which confine the flow in the Delta, are built of unstable sandy material, they weaken quickly and soon give way to the active forces of floodwaters. Any storm with a peak discharge of about 5,500 cubic feet per second or greater is likely to cause breaks in the levees, causing sand deposits near these breaks and resulting in inundation of farmland.

The extent of damage resulting from levee failure depends on the magnitude of the storm, the number and location of levee breaks, and the season of the year. As nearly as can be determined, there is no continuity or pattern in levee failures from storms of any magnitude. Information available indicates that 50 percent of the levee breaks occur between the planting and harvesting seasons for row crops grown in the area. Records of levee breaks by the Corps since January 1946 indicate that there have been more than 20 floods with numerous breaks in the levee for each flood. With each flood, there is an increase in amount of sand deposited near the levee. This deposition of sand ruins the fertile bottom lands and causes channel aggradation, which diminishes the capacity of channels to carry off the floodwaters.

Pelucia Creek Upland Watershed

Pelucia Creek lies in Leflore and Carroll Counties and flows in a westerly direction. In the upper reaches of the watershed, it is about 14 miles long and 9 miles wide. South of Carrollton, Miss., State Highway 17 crosses the watershed in a north-south direction. West of this highway, the watershed averages about 3 miles in width. East of the highway, the tributary fans out in typical dendritic pattern.

The watershed lies within the Loess Resource Area. From Mississippi State Highway 17 westward the loess soil is very deep and highly dissected, with moderate sheet and gully erosion. Several active gravel pits contribute materially to the total amount of sand delivered to the alluvial flood plain.

East of Mississippi State Highway 17, the loess soil decreases in depth, and dissection of the landscape lessens, but sheet and gully erosion is very severe. Streambank erosion in the area is severe also. Estimates of loss of land through streambank erosion show about 1.1 acres per channel mile per year between the valley and Mississippi State Highway 17, and about 0.45 acre per channel mile per year above the highway.

Other Upland Watersheds

The upland watersheds (fig. 40) studied in Mississippi include Potococowa-Teoc Creeks and Abiaca Creek in Carroll County and Chicopa, Fannegusha, and Black Creeks in Holmes County. Each of these watersheds lies in the Loess Resource Area and each has problems common to all. In the western portions of the watersheds, the slopes are very steep and a high percentage of the land is in woods and pasture. The soils are of very deep loess with only moderate sheet and gully erosion. Toward the central and eastern portions of the watersheds, the topography becomes less steeply rolling, but erosion becomes very severe. Many active gullies have penetrated the loess soil into the unconsolidated sands of coastal-plain origin. Land use changes into more pasture on the hills as compared with the broad valleys, which contain a majority of the row crops grown and are usually free of flood damage because of the deep, wide channels.

The characteristics of the problem area in each watershed, as shown on figure 40 are described as follows:

L-1. Deep, very fertile, well-drained loess soils on very steep slopes. This area is predominantly in forest on the whole, and erosion is not too severe. Where the land has been cleared, sheet and gully erosion are very severe. These soils erode rapidly. Ridges and valleys are narrow; the valleys are V-shaped without too much alluvium. The area is particularly adapted to timber.

L-5. Deep, fertile, well-drained loess soils on upper parts of slopes and on ridges, but becoming thin over friable sandy coastal-plain material on the lower portions of slopes. Erosion is very severe. Much of the area is too steep for cultivation and has been cleared, cropped, and abandoned. Ridges range from narrow to medium width and slopes from strongly rolling to very steep. Valleys are of medium width and contain much of the cropland of the area.

L-6. Rough, thin loess hills with well-drained thin loess over friable sandy material on very steep slopes. Much of this land has been cleared and both sheet and gully erosion are severe. Ridges are usually narrow, but some widen. Soils on the moderate slopes are fairly deep and show moderate to severe erosion. Valleys are fairly narrow and usually need drainage.

L-19. Better lying valley and adjacent hill land. Valleys are broad and have imperfectly to well-drained, silty alluvial soils of good quality. Local drainage is needed. Steambank caving is serious. Adjacent to the valleys are varying amounts of terrace and hill lands having moderately deep, silty soils on gently to strongly rolling slopes. Erosion is moderate to severe. Most of the land in this area has been cleared and is in crops, although some has been abandoned.

L-24. Predominantly deep with some moderately deep soils of thin loess over sandy coastal-plain material on strongly sloping to steep slopes. Occasional areas of moderately sloping land occur. Both sheet and gully erosion are severe. Considerable abandonment of land has occurred in this area and natural reseeding processes are covering appreciable acreages of land with young pine. Cropping is generally restricted to the medium width, moderately productive valleys. Valley sanding is becoming a problem in local areas.

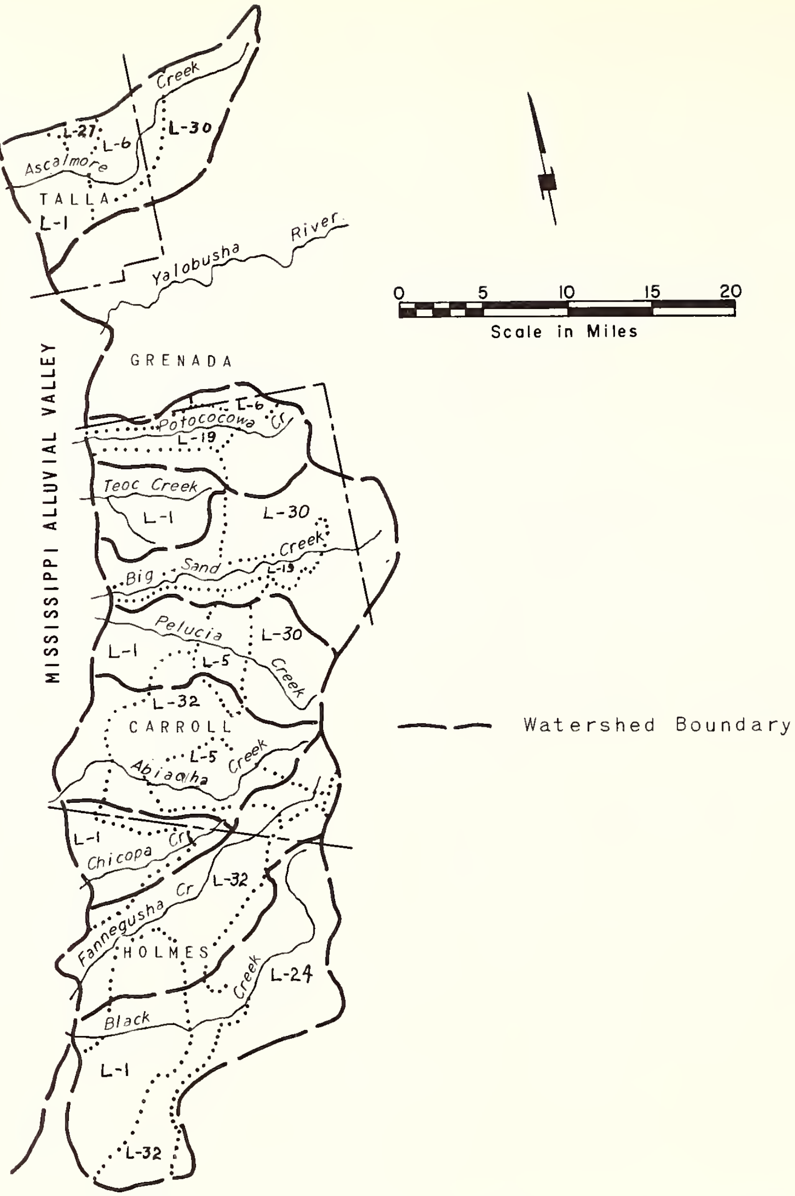


Figure 40.--Location map, Hill Tributaries Bluff Area, Yozoa Headwater Project, Mississippi.

L-27. Mixed deep and moderately deep loess, predominantly on moderate slopes, although gentle and strong slopes occur. Sheet erosion tends to be severe and some gullying has occurred. Bottoms are broad, with silty soils which usually are moderately well drained. Some drainage is needed locally. The land in this area is predominantly open, and much of it is in crops, although some land abandonment has occurred.

L-30. Deep, well-drained loess soils on ridgetops and upper portions of side slopes, becoming deep, well-drained thin loess over sandy material on lower portions of side slopes. Ridgetops range from medium width to narrow and are usually strongly sloping to steep, while side slopes are steep to very steep. Sheet erosion is very severe and gullies are numerous and spectacular. Abandonment of hill land is common. Valleys are medium width, with silty and good quality soils, which make up a large part of the cropland in this area.

L-32. Deep, well-drained, fairly productive loessial soils on moderately and strongly sloping broad ridgetops. Side slopes are

steep to very steep. Sheet and gully erosion are very severe. Bottoms range from medium width to wide, and are made up of moderately well-drained, productive silty alluvial soils. Drainage is needed locally. Nearly all of the land in this area has been cleared and cropped. Severe erosion has caused considerable land abandonment. Grazing land is gradually developing.

PROPOSED WATER-CONTROL PROJECTS IN MISSOURI

New Madrid Floodway Levee Closure Project

The proposed New Madrid Floodway Levee Closure Project (fig. 41) consists of a levee closure near the lower end of the existing New Madrid Floodway. The levee closure would include gated drainage facilities to prevent backwater flooding from the Mississippi River without impairing interior drainage. The project area contains 117,300 acres.

The present level of backwater flooding is elevation 300 MSL, which can be expected once in 10 years. Infrequent flooding may occur up to elevation 304. With the closure in place, in most years, flooding would be confined to an area below elevation 292. The zone above elevation 304 is free from flood hazards. That between elevations 304 and 292 is subject to

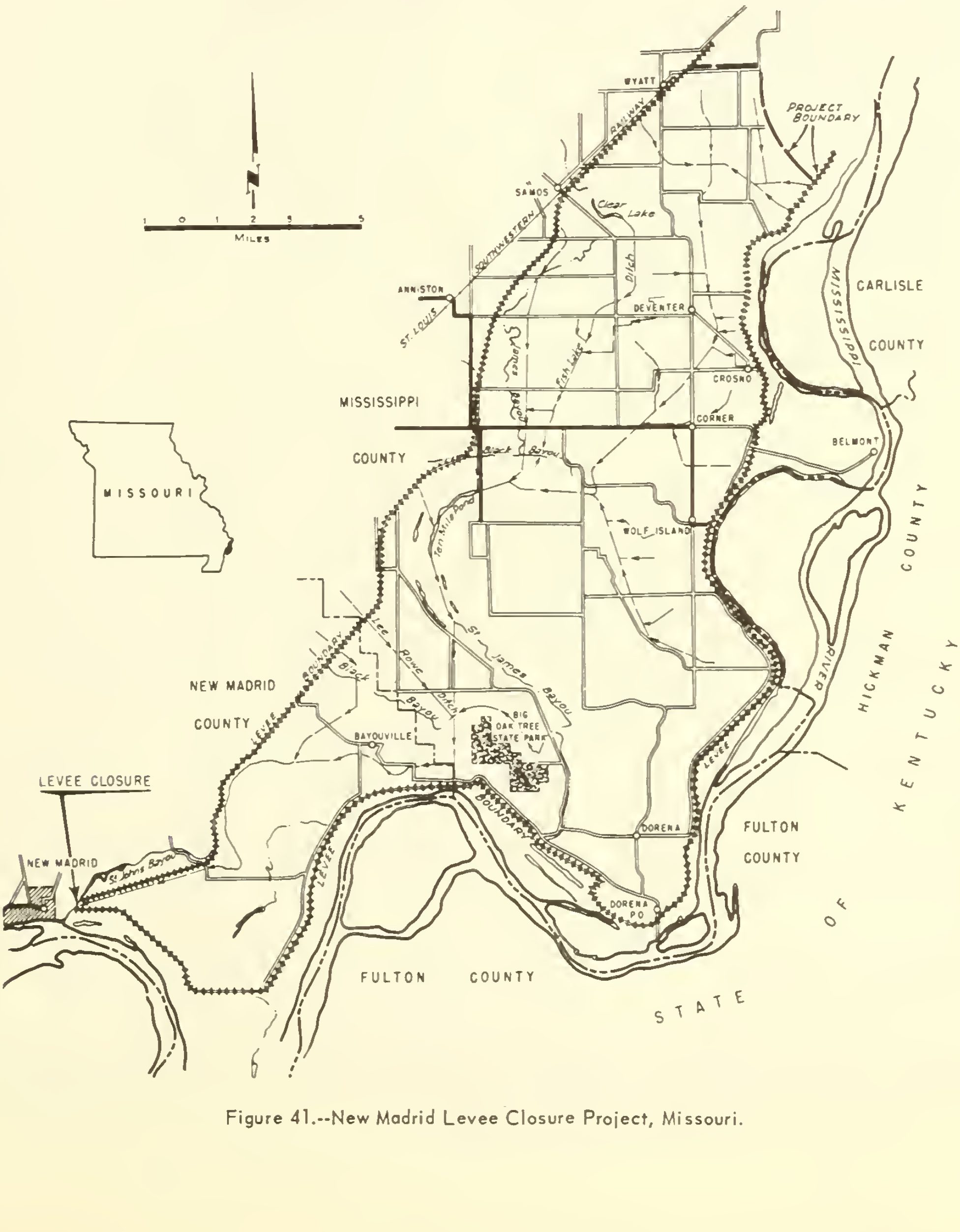


Figure 41.--New Madrid Levee Closure Project, Missouri.

flooding, which would be alleviated by the project. Flooding up to elevation 293 could be expected once in 10 years. The area below 292 would not benefit from project drainage.

The soils of the area range from fine-textured, very slowly permeable poorly drained clay soils to medium and moderately coarse-textured well-drained soils. Nearly two-thirds of the area is composed of the fine-textured, poorly drained clay soils and about one-third is composed of the medium to coarse-textured well-drained soils.

The poorly drained clay soils are the most poorly developed for agricultural production but constitute some of the highest potential production increments from drainage improvement. Throughout the area the topography is flat to depressional, and during periods of excessive rainfall, which usually occur several times each cropping season, surface flooding and waterlogging prevail. Some farm and group drainage facilities have been provided, but these systems are of limited effectiveness because outlets are inadequate. If adequate surface drainage were provided, these heavy soils could be made much more productive. In the area are 52,000 acres of the heavy, poorly drained clay soils, 12 percent of which lie within the flood-free A zone, 46 percent within the B zone, which is subject to flooding but would be protected by the project, and 42 percent within the sump area, the C zone.

The medium- to coarse-textured soils occur on undulating topography usually adjacent to the Mississippi River and natural swales. These soils are well to moderately well drained and much more highly developed agriculturally. A total of 42,800 acres, or 37 percent, is composed of these soils. The soils occur as follows: 31 percent in the A zone, 68 percent in the B zone, and 1 percent in the C zone.

About 19 percent 22,500 acres, is composed of moderately coarse-textured, well-drained soil. Eighteen percent of this soil occurs in the A zone, 65 percent within the B zone, and 17 percent within the C zone.

About 69 percent of the project area is open land, the remaining 31 percent is wooded. A very minor part of the project area is watered. The well-drained soils comprise 88 percent open land and 12 percent wooded. The poorly drained, fine-textured soils comprise 69 percent open land and 31 percent wooded.

USDA estimated that with adequate flood protection and drainage, all land in the A and B zones and 66 percent of the land in the C zone would be open land. It anticipated that 92 percent of the expected open land in the A and B zones would be drained if flood protection and drainage were provided in the New Madrid Floodway. The changes in major land use and in percentage of open land drained, by soil units, in each of the zones estimated by USDA to occur with project development are given in table 100.

USDA estimated that, assuming adequate flood

TABLE 100.--New Madrid Floodway Levee Closure: Major land use and drainage, present and estimated future without and with project, soil units and zones

Item	All land in zone			Percentage of zone in--						Percentage of open land drained[1]		
				Open land			Woodland					
	A	B	C	A	B	C	A	B	C	A	B	C
Soil unit 1:	*100 acres*	*100 acres*	*100 acres*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Present	64	239	217	100	79	23	0	21	77	0	0	0
Without project	64	239	217	100	92	60	0	8	40	0	3	0
With project	64	239	217	100	100	60	0	0	40	90	90	0
Soil unit 4:												
Present	43	103	2	100	86	21	0	14	79	0	0	0
Without project	43	103	2	100	96	100	0	4	0	0	3	0
With project	43	103	2	100	100	100	0	0	0	90	90	0
Soil unit 6:												
Present	89	187	5	100	90	37	0	10	63	0	0	0
Without project	89	187	5	100	97	100	0	3	0	0	2	0
With project	89	187	5	100	100	100	0	0	0	90	90	0
Soil unit 11:												
Present	41	146	37	100	95	44	0	5	56	100	100	0
Without project	41	146	37	100	100	100	0	0	0	100	100	0
With project	41	146	37	100	100	100	0	0	0	100	100	0
All:												
Present	237	675	261	100	87	26	0	13	74	17	24	0
Without project	237	675	261	100	96	66	0	4	34	17	24	0
With project	237	675	261	100	100	66	0	0	34	92	92	0

[1] Includes naturally and artificially drained land.

protection and drainage, total agricultural production in the New Madrid Floodway would increase 32 percent and net agricultural income 45 percent. These increases are expected to result from changes in major land use and in cropping distribution, as shown in tables 101 and 102.

Woodland expected to be cleared and drained with project development would total 3,000 acres. About 75,800 acres of farmland including the converted woodland are anticipated to be drained if flood protection and drainage are provided. As indicated in table 103, the total associated cost of land development in the New Madrid Floodway was estimated by the USDA at $1,706,100, with an annual equivalent of $217,000 including annual cost of drainage maintenance. The total increase in annual net

TABLE 101.--New Madrid Floodway Levee Closure: Estimated effects of project development on cropping systems[1]

Crop	Percentage change in acreage			Percentage change in production			Percentage change in net return		
	A zone	B zone	All land	A zone	B zone	All land	A zone	B zone	All land
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Cotton	1	9	6	12	26	21	46	54	48
Corn	6	14	10	81	99	82	82	93	81
Alfalfa	30	24	22	55	43	41	40	50	43
Soybeans	-31	-31	-25	-5	-3	-3	9	13	10
Wheat	17	8	10	37	27	27	43	29	32
Permanent pasture	111	194	128	153	294	195	159	281	88
Idle	0	0	0						
Other	0	5	3						
Woodland	0	-100	-25	0	-100	-25	0	-100	-20
All land	0	0	0	30	40	32	47	55	45

[1] No change in acreage, production, or net return in C zone. "All land" includes C zone.

TABLE 102.--New Madrid Floodway Levee Closure: Estimated future crop acreages, crop production, and net return without and with project development

Crop	Without project			With project			Difference in net return	Percentage increase in net return
	Acres	Production[1]	Net return	Acres	Production[1]	Net return		
	100 acres	*1,000 units*	*1,000 dollars*	*100 acres*	*1,000 units*	*1,000 dollars*	*1,000 dollars*	*Percent*
Cotton	135	11	159	144	13	235	76	48
Corn	272	839	525	298	1,529	951	426	81
Alfalfa	55	17	154	67	25	221	67	43
Soybeans	362	724	731	272	701	804	73	10
Wheat	77	168	79	84	214	103	24	32
Permanent pasture	49	664	76	112	1,961	221	145	88
Idle	0			0				
Other	105			108				
Woodland	118		44	88		36	-8	-20
Total	1,173		1,768	1,173		2,571	803	45

[1] Cotton--500-pound bales; corn, soybeans, oats, and grain sorghum--bushels; rice--hundredweights; beef--pounds.

TABLE 103.--New Madrid Floodway Levee Closure Area: Project summary

Item	Amount
Drainage operations:	
Woodland converted to open	*Acres*
cropland......................	3,000
Farmland drained................	75,800
Associated costs:	
Initial:	*Dollars*
Woodland conversion...........	238,000
Farm drainage installations....	564,100
Group drainage installations...	904,000
Total associated costs.......	1,706,100
Annual equivalent:	
Conversion....................	13,000
Farm drainage.................	44,900
Group drainage................	87,800
Annual farm drainage maintenance.	71,300
Total annual costs..........	217,000
Annual increase in net farm income.	803,200
Discounted value of:	
Annual increase in net farm	
income........................	482,300
Annual associated costs..........	184,600
Unadjusted benefits..........	297,700

agricultural income was estimated at $803,200. Total discounted values of annual increase in net agricultural income and annual associated costs were estimated at $482,300 and $184,600, respectively.

St. Francis River and Tributaries Project

The proposed St. Francis River and Tributaries Project in Missouri (fig. 42) extends from the northwest corner of Stoddard County southward through Dunklin County to near the Arkansas line; also included is a small area of Clay County, Ark. The project proposes these improvements:

1. St. Francis River channel improvements and realignment from Fisk to Crowley's Ridge, and major drainage improvements to the entire length of Mingo Ditch from the Mingo National Wildlife Refuge south; Dudley Ditch from St. Francis River to the intersection with Lick Creek, Ditch 12, and extending up Lick Creek, Ditch 12, to a point about 2 miles above U. S. Highway 60; Main Ditch from St. Francis River north to the intersection of lateral 1 about $2\frac{1}{2}$ miles northeast of Glennonville, Mo. This section of the proposed project is designed to serve as a major outlet for farm drainage systems for 112,900 acres, and to provide additional capacity for adjacent upland drainage.
2. Drainage improvements on Ditches 19 and 36 extending from the intersection of Dunklin County Highway "J" and Ditch 19 southward to the junction of Ditches 19 and 36. Improvement of Varney River extending from the junction of Varney River and Shipley Slough southwesterly to its confluence with the St. Francis River. This part of the project is designed to serve as major outlets for 114,000 acres and provide capacity for additional drainage from Crowley's Ridge into Ditches 19 and 36.
3. Drainage improvements on Ditch 81 and in the Elk Chute and Treasure Island areas. This proposed improvement is designed to serve as major drainage outlets for farm drainage systems for 12,700 acres.

The topography of the St. Francis Basin in Missouri is generally flat to undulating. Soils range from fine-textured, poorly drained, to sandy, excessively drained.

The upper area west of Crowley's Ridge is mainly of medium-textured, poorly drained soils. Roughly, two-thirds of this upper area is rather low-lying, silty, poorly drained bottom land and second bottom land. The topography is undulating to nearly level with many depressions and old meander channels.

Soils in the northern and major part of the project area east of Crowley's Ridge are mixed; they range from sandy, excessively drained to fine-textured, poorly drained. The southern fourth of this area has well-drained silty soils on a rather high terrace; and fine-textured, poorly drained soils on the rest. The remaining three-fourths consists of above 65 percent sandy soils, most of which are droughty and excessively drained, and 35 percent poorly drained fine- and medium-textured soils in low-lying swales.

The remaining southern and easternmost part of the area east of Crowley's Ridge and the St. Francis River is made up chiefly of poorly drained fine-textured soils intermingled with sand spots and sandy streaks. Occasional moderately sized areas of sandy, excessively drained soils occur but they are in the minority.

In general, the poorly drained soils are the most poorly developed for agricultural production. Surface drainage and adequate outlets for farm drainage systems are needed. The well-drained silty and sandy soils usually occupy areas of higher ground, with wet swales and depressions occuring frequently. Wind erosion and inadequate soil-moisture-holding capacity are problems on the sandy excessively drained soils.

The project area contains 239,600 acres. Fine-textured, poorly drained soils in the lower elevations total 42,800 acres, or 18 percent of the area. Medium-textured, poorly drained soils at the lower elevations comprise 2,900 acres, or 1 percent. Medium-textured, poorly drained soils on tributary streams and low terraces occupy 86,200 acres and account for 36 percent;

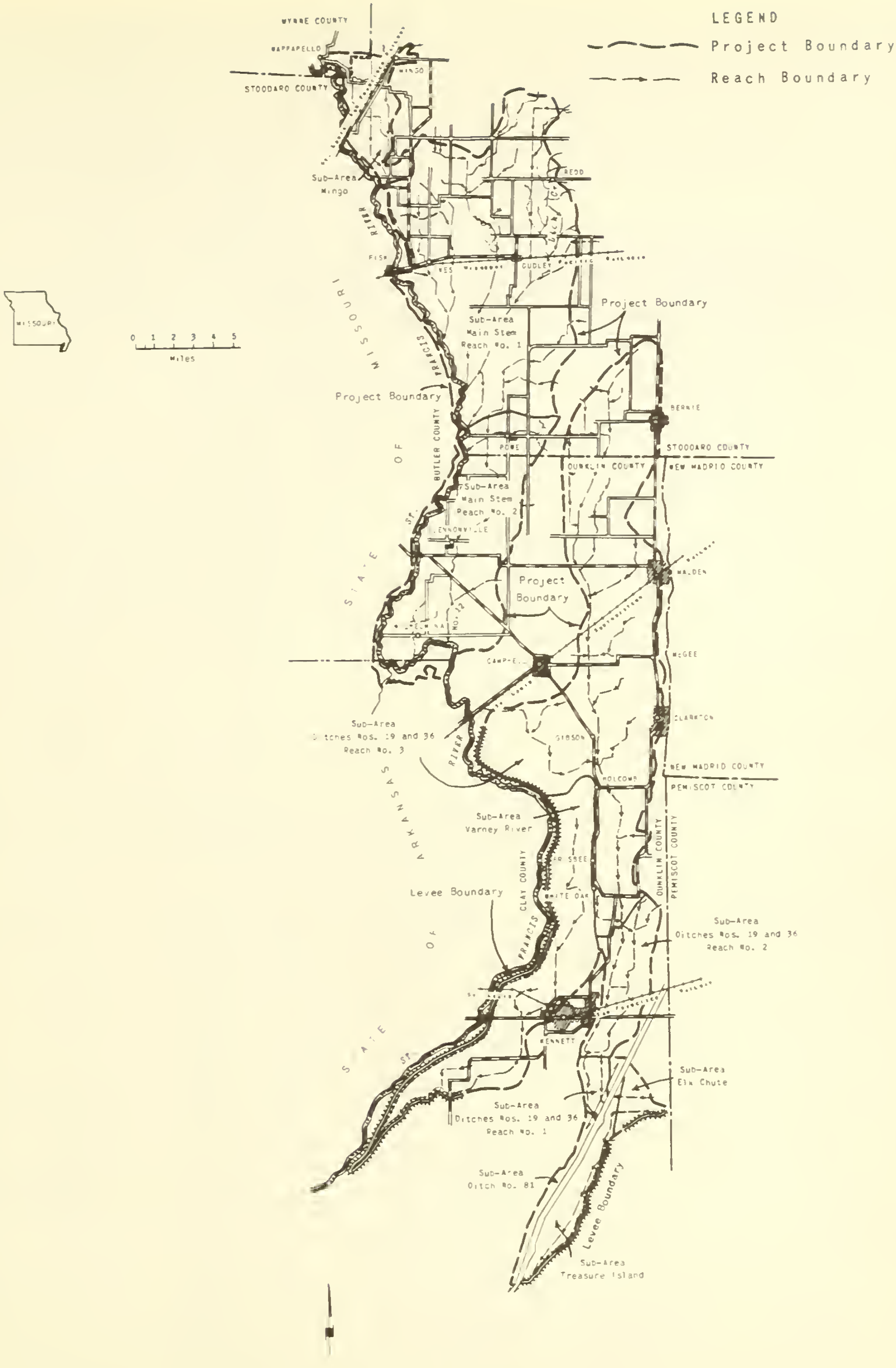


Figure 42.--St. Francis River and Tributaries Project, Missouri.

while soils occupying terraces comprise 46,700 acres, or 20 percent.

Medium-textured, well-drained soils on loess terraces occupy 17,600 acres, and those on upland loess hills 500 acres; together they account for 7 percent.

Coarse, excessively drained soils account for 33,400 acres, or 14 percent; and wet poorly drained sandy soils account for 9,500 acres, or 4 percent.

About 75 percent of the St. Francis Basin in Missouri is open land, 25 percent is wooded, and less than 1 percent is covered by water.

It was estimated that if adequate flood protection and drainage were provided in the St. Francis River Basin, 90 percent of all land in the A zone, 87 percent of all land in the B zone, and 7 percent of all land in the C zone would be open land. USDA estimated that 80 percent of the open land in the A zone, 95 percent of the open land in the B zone, and none of the open land in the C zone would be drained with project development. Table 104 shows USDA estimate of changes in major land use and in percentage of open land drained under assumptions of flood protection and drainage.

USDA estimated that if adequate flood protection and drainage were provided in the St. Francis River Basin in Missouri, total agricultural production could be increased 45 per-

TABLE 104.--St. Francis River Basin: Major land use and drainage, present and estimated future without and with project, soil units and zones

Item	All land in zone			Percentage of zone in--						Percentage of open land drained[1]		
				Open land			Woodland					
	A	B	C	A	B	C	A	B	C	A	B	C
	100 acres	*100 acres*	*100 acres*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Soil unit 3:												
Present................	208	220		97	94		3	6		0	0	
Without project........	208	220		97	94		3	6		0	0	
With project...........	208	220		100	100		0	0		91	98	
Soil unit 6:												
Present................	29			96			4			0		
Without project........	29			96			4			0		
With project...........	29			100			0			90		
Soil unit 8:												
Present................	459	324	79	62	35	7	38	65	93	0	0	0
Without project........	459	324	79	64	45	7	36	55	93	0	0	0
With project...........	459	324	79	78	78	7	22	22	93	81	76	0
Soil unit 9:												
Present................	171	5		99	98		1	2		25	0	
Without project........	171	5		99	98		1	2		25	0	
With project...........	171	5		100	100		0	0		81	80	
Soil unit 10:												
Present................	418	49		71	53		29	47		0	0	
Without project........	418	49		73	61		27	39		0	0	
With project...........	418	49		85	85		15	15		80	75	
Soil unit 12:												
Present................	329	5		98	96		2	4		0	0	
Without project........	329	5		98	96		2	4		0	0	
With project...........	329	5		100	100		0	0		70	80	
Soil unit 15:												
Present................	4			100			0			100		
Without project........	4			100			0			100		
With project...........	4			100			0			100		
Soil unit 16:												
Present................	94	1		92	100		8	0		0	0	
Without project........	94	1		92	100		8	0		0	0	
With project...........	94	1		99	100		1	0		81	90	
All:												
Present................	1,712	604	79	81	59	7	19	41	93	3	0	0
Without project........	1,712	604	79	82	65	7	18	35	93	3	0	0
With project...........	1,712	604	79	90	87	7	10	13	93	80	95	0

[1] Includes naturally and artificially drained land.

cent and net agricultural income 78 percent. These increases are expected to result from changes in major land use and in cropping distribution, as indicated in tables 105 and 106.

Woodland expected to be converted and drained with project development would total 27,000 acres. USDA estimated that 147,700 acres of farmland, including the converted woodland, would be drained if adequate flood protection and drainage were provided. As shown in table 107, the total associated cost of land development in the St. Francis Basin in Missouri was estimated at $2,766,400, with the annual equivalent including annual cost of drainage maintenance at $317,200. The total annual increase in net agricultural income was estimated at

TABLE 105.--St. Francis River Basin: Estimated effects of project development on cropping systems[1]

Crop	Percentage change in acreage			Percentage change in production			Percentage change in net return		
	A zone	B zone	All land	A zone	B zone	All land	A zone	B zone	All land
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Cotton..................	1	16	4	22	70	33	92	748	155
Corn....................	4	97	18	56	246	84	92	346	131
Melons..................	-2		2	10		15	39		45
Soybeans................	4	-2	2	28	24	27	45	41	43
Wheat...................	26	112	37	44	151	58	55	183	70
Lespedeza pasture.......	405	95	304	593	179	460	600	217	482
Grain sorghum...........	-41	-56	-42	-15	-42	-18	4	-34	0
Permanent pasture.......	101	356	134	185	561	234	173	607	224
Idle....................	-66	-100	-70						
Other...................	10	34	15						
Woodland................	-46	-63	-47				-42	-63	-45
All land...........	0	0	0	39	67	45	73	98	78

[1] No change in acreage, production, or net return in C zone. "All land" Includes C zone.

TABLE 106.--St. Francis River Basin: Estimated future crop acreages, crop production, and net return without and with project development

Crop	Without project			With project			Difference in net return	Percentage increase in net return
	Acres	Production[1]	Net return	Acres	Production[1]	Net return		
	100 acres	*1,000 units*	*1,000 dollars*	*100 acres*	*1,000 units*	*1,000 dollars*	*1,000 dollars*	*Percent*
Cotton..............	374	21	152	390	29	388	236	155
Corn................	371	854	430	437	1,578	992	562	131
Melons..............	12	359	11	12	412	16	5	45
Soybeans............	512	916	849	522	1,159	1,216	367	43
Wheat...............	204	361	162	279	528	275	113	70
Lespedeza pasture...	[2] (48)	531	38	(193)	2,973	221	183	482
Grain sorghum.......	14	25	14	8	21	14	0	0
Permanent pasture...	90	972	102	211	3,247	331	229	224
Idle................	50			15				
Other...............	181			208				
Woodland............	587		262	313		145	-117	-45
Total..........	2,395		2,020	2,395		3,598	1,578	78

[1] Cotton--500-pound bales; corn, soybeans, oats, and grain sorghum--bushels; rice--hundredweights; beef--pounds.

[2] Duplicated acreage.

TABLE 107.--St. Francis River Basin, Missouri: Project summary

Item	Amount
Drainage operations:	
Woodland converted to open	*Acres*
cropland	27,400
Farmland drained	147,700
Associated costs:	
Initial:	*Dollars*
Woodland conversion	1,670,000
Farm drainage installations	968,600
Group drainage installations	127,800
Total associated costs	2,766,400
Annual equivalent:	
Conversion	84,900
Farm drainage	86,700
Group drainage	34,200
Annual farm drainage maintenance	111,400
Total annual costs	317,200
Annual increase in net farm income	1,577,700
Discounted value of:	
Annual increase in net farm income	1,280,300
Annual associated costs	308,500
Unadjusted benefits	971,800

$1,577,700. Total discounted values of increase in net agricultural income and annual associated costs were estimated at $1,280,300 and $308,500, respectively.

St. Johns Bayou Project

The St. Johns Bayou project (fig. 43) consists of a pumping plant at the St. Johns Bayou floodgate in New Madrid County and improvement of St. Johns main ditch from the floodgate upstream to the St. Louis-Southwestern Railroad crossing. These proposed project features are intended to reduce the extent of flooding of the project area and to provide major drainage outlets for 98,700 acres and additional capacity for adjacent upland drainage.

The soils of the area include fine-textured, poorly drained clay; silty medium-textured soils of moderate to slow drainage; silty and sandy overwash soils; and sandy excessively drained soils. By far the greater portion of the soil areas occur on nearly level to depressional topography. In general, the heavier, more poorly drained soils occur at the lower elevations with the siltier and better-drained soils on slightly higher elevations or with slightly

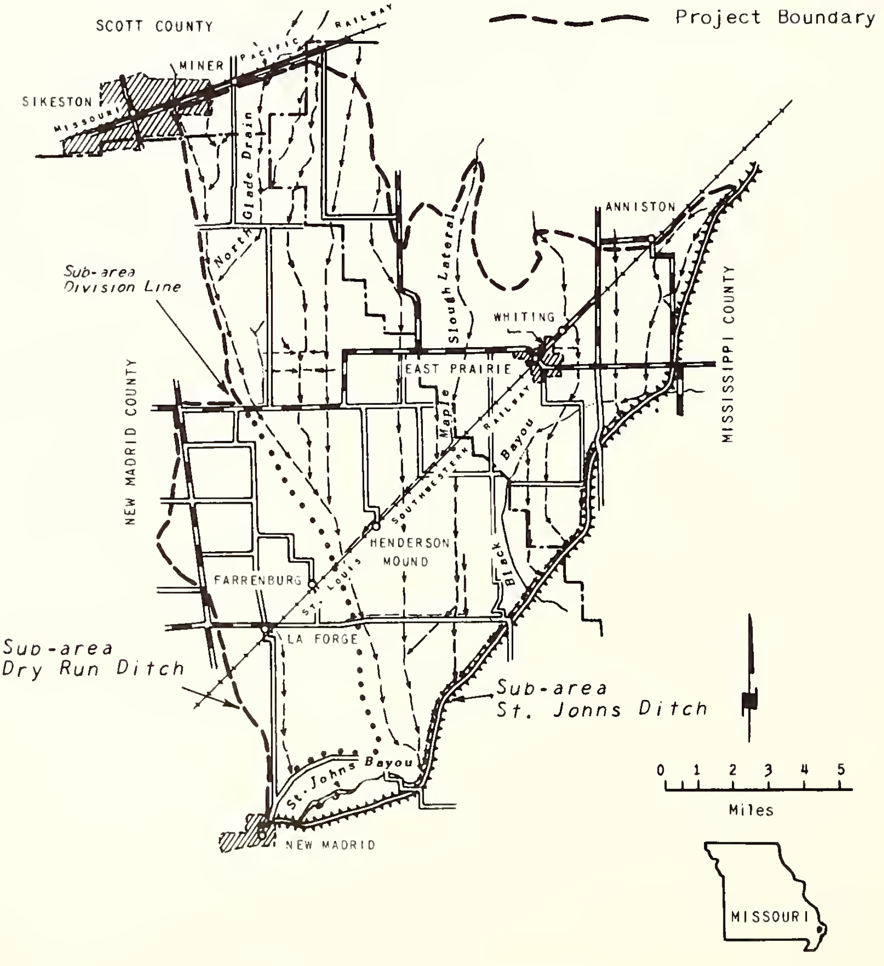


Figure 43.--St. Johns Bayou Project.

more gradient. The sandy soils are normally at the higher elevations.

A total of 49,600 acres, or 50 percent of the project area, consists of fine-textured, poorly drained, and somewhat poorly drained soil. This soil is distributed among the flooding zones as follows: 50 percent is in the zone subject to flooding, which would be relieved by the proposed project; 33 percent is in the flood-free zone; and 17 percent is in the undrained sump area.

Medium-textured, moderately drained soils make up 5,400 acres, or 5 percent. Fifty percent is in the flood-free zone; 46 percent is in the zone subject to flooding; and 4 percent is in the sump area.

About 17 percent consists of fine-textured, poorly drained, overwashed soils, similar to the fine-textured, heavy, poorly drained soils that occur on 50 percent of the project area. The former differ, however, in that they have a recently deposited silty-textured surface material from depths of 8 to 12 inches. The soils are poorly drained but because of the silty overwash material, they dry out in the surface somewhat sooner than the heavier-textured soils. Of these soils, 4,300 acres occur in the flood-free zone, 12,400 acres in the zone subject to flooding which the proposed project is designed to relieve, and 300 acres in the undrained zone of the project area.

A total of 8,000 acres, or about 9 percent, consists of well- and moderately well-drained, medium-textured silty soils. In general, these soils are on the slightly higher elevations. All of these soils are in the flood-free zone.

About 18,700 acres consist of soils of medium-textured loam to coarse-textured sand, which are excessively drained. About 17,600 acres of these soils occur in the flood-free zone, and 1,100 acres are subject to flooding. No soils of these types are in the sump area.

About 83 percent is open land, 15 percent is wooded land, and urban and watered areas account for 1 percent each. More than 99 percent of the flood-free zone is open land. Of the total wooded area, a little more than half occurs in the area subject to flooding and slightly less than half is in the C zone.

USDA estimated that assuming adequate flood protection and drainage all land in the A zone, 97 percent of the land in the B zone, and 44 percent of the land in the C zone would be open land. Under these assumptions, it was estimated that 95 percent of the open land in the A zone and 90 percent of the open land in the B zone would be drained. The estimated changes in major land use and in the percentage of open land drained are shown in table 108.

USDA estimated that total agricultural production could be increased 31 percent and net agricultural income 47 percent if adequate flood protection and drainage were provided in the St. Johns Bayou Project area. The estimated effects of the project on crop acreages, production, and net income in the area are shown in tables 109 and 110.

It was estimated that 50,000 acres of farmland, including 4,200 acres of woodland that would be converted and drained, would be drained with the project development. Total associated cost of the land development was estimated by USDA at $913,500, and the annual equivalent at $138,000. Total annual increase in net agricultural income, as shown in table 111, was estimated at $703,100. The discounted values of annual increase in net agricultural income and annual associated costs were estimated at $557,400 and $110,000, respectively.

TABLE 108.--St. Johns Bayou Project: Major land use and drainage, present and estimated future without and with project, soil units and zones

Item	All land in zone			Percentage of zone in						Percentage of open land drained[1]		
				Open land			Woodland					
	A	B	C	A	B	C	A	B	C	A	B	C
	100 acres	*100 acres*	*100 acres*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Soil unit 1:												
Present.................	96	238	82	100	75	21	0	25	79	0	0	0
Without project.........	96	238	82	100	81	41	0	19	59	0	0	0
With project............	96	238	82	100	95	41	0	5	59	90	90	0
Soil unit 2:												
Present.................	67	3		99	91		1	9		0	0	
Without project.........	67	3		99	100		1	0		0	0	
With project............	67	3		100	100		0	0		90	90	
Soil unit 3:												
Present.................		8			34			66			0	
Without project.........		8			100			0			0	
With project............		8			100			0			90	

See foonote at end of table.

TABLE 108.--St. Johns Bayou Project: Major land use and drainage, present and estimated future without and with project soil units and zones--Continued

Item	All land in zone			Percentage of zone in						Percentage of open land drained[1]		
				Open land			Woodland					
	A	B	C	A	B	C	A	B	C	A	B	C
	100 acres	*100 acres*	*100 acres*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*
Soil unit 4:												
Present.................	28	25	2	100	95	100	0	5	0	0	0	
Without project.........	28	25	2	100	99	100	0	1	0	0	0	
With project............	28	25	2	100	100	100	0	0	0	90	90	
Soil unit 6:												
Present.................	43	124	3	98	90	100	2	10	0	0	0	0
Without project.........	43	124	3	98	93	100	2	7	0	0	0	0
With project............	43	124	3	98	98	100	2	2	0	90	90	0
Soil unit 9:												
Present.................	80			100			0			100		
Without project.........	80			100			0			100		
With project............	80			100			0			100		
Soil unit 11:												
Present.................	176	12		100	92		0	8		100	100	
Without project.........	176	12		100	100		0	0		100	100	
With project............	176	12		100	100		0	0		100	100	
All:												
Present.................	490	410	87	99	80	25	1	20	75	52	3	0
Without project.........	490	410	87	99	87	44	1	13	56	52	3	0
With project............	490	410	87	100	97	44	0	3	56	95	90	0

[1] Includes naturally and artificially drained land.

TABLE 109.--St. Johns Bayou Project: Estimated effects of project development on cropping systems[1]

Crop	Percentage change in acreage			Percentage change in production			Percentage change in net return		
	A zone	B zone	All land	A zone	B zone	All land	A zone	B zone	All land
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Cotton....................	-9	14	1	7	61	25	31	259	76
Corn......................	4	10	6	33	94	51	37	121	61
Soybeans..................	-5	-15	-9	15	27	20	23	54	35
Wheat.....................	11	21	13	18	58	28	22	73	35
Lespedeza pasture.........	74	164	95	81	402	130	85	495	141
Permanent pasture.........	12	553	86	23	868	92	11	831	53
Idle......................	0	0	0						
Other.....................	0	12	5						
Woodland..................	-28	-75	-39	-28	-75	-36	-28	-75	-36
All land..............	0	0	0	17	60	31	28	90	47

[1] No change in acreage, production, or net return in C zone. "All land" includes C zone.

TABLE 110.--St. Johns Bayou Project: Estimated future crop acreages, crop production, and net return without and with project development

Crop	Without project			With project			Difference in net return	Percentage increase in net return
	Acres	Production[1]	Net return	Acres	Production[1]	Net return		
	100 acres	*1,000 units*	*1,000 dollars*	*100 acres*	*1,000 units*	*1,000 dollars*	*1,000 dollars*	*Percent*
Cotton	185	13	163	186	16	287	124	76
Corn	196	673	412	207	1,020	665	253	61
Soybeans	278	598	622	254	716	842	220	35
Wheat	89	218	104	101	279	140	36	35
Lespedeza pasture	[2] (19)	343	27	(37)	789	65	38	141
Permanent pasture	44	1,024	106	82	1,964	162	56	53
Idle	0			0				
Other	88			92				
Woodland	107		66	65		42	-24	-36
Total	987		1,500	987		2,203	703	47

[1] Cotton--500-pound bales; corn, soybeans, oats, and grain sorghum--bushels; rice--hundredweights; beef--pounds.
[2] Duplicated acreage.

TABLE 111.--St. Johns Bayou Area: Project summary

Item	Amount
Drainage operations:	
Woodland converted to open cropland	*Acres* 4,200
Farmland drained	50,000
Associated costs:	
Initial:	*Dollars*
Woodland conversion	293,400
Farm drainage installations	496,700
Group drainage installations	123,400
Total associated costs	913,500
Annual equivalent:	
Conversion	16,100
Farm drainage	47,500
Group drainage	13,800
Annual farm drainage maintenance	60,600
Total annual costs	138,000
Annual increase in net farm income	703,100
Discounted value of:	
Annual increase in net farm income	557,400
Annual associated costs	110,000
Unadjusted benefits	447,400

Lower Mississippi River and Tributaries Project in Missouri

As indicated in table 112, USDA estimated that if adequate flood protection and drainage were provided in the project areas in Missouri, 93 percent of all land in the A zone of the project areas, 95 percent of all land in the B zone, and 51 percent of all land in the C zone would be open land. Of the estimated open land with the project, USDA anticipated that 84 percent in the A zone and 90 percent in the B zone would be drained.

Assuming flood protection and the construction of adequate drainage outlets in the MR&T Project area in Missouri, USDA estimated that total agricultural production in the project areas could be increased 38 percent and annual net agricultural income 58 percent. These increases would result from estimated changes in cropping systems and in major land use as indicated in tables 113 and 114.

It was anticipated that 273,200 acres of farmland, including 34,600 acres of converted woodland, would be drained if adequate flood protection and drainage facilities were provided in the project areas. The total associated cost of land development in the project areas in Missouri was estimated by USDA at $5,385,000, and the annual equivalent at $672,000, including annual

TABLE 112.--Lower Mississippi River and Tributaries Project, Missouri: Major land use and drainage, present and estimated future without and with project, soil units and zones

Item	All land in zone			Percentage of zone in--						Percentage of open land drained[1]		
				Open land			Woodland					
	A	B	C	A	B	C	A	B	C	A	B	C
	100 acres	*100 acres*	*100 acres*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Soil unit 1:												
Present	160	477	299	100	77	22	0	23	78	0	0	0
Without project	160	477	299	100	86	54	0	14	46	0	1	0
With project	160	477	299	100	98	54	0	2	46	90	90	0
Soil unit 2:												
Present	67	3		99	100		1	0		0	0	
Without project	67	3		99	100		1	0		0	0	
With project	67	3		100	100		0	0		90	100	
Soil unit 3:												
Present	208	228		97	92		3	8		0	0	
Without project	208	228		97	95		3	5		0	0	
With project	208	228		100	100		0	0		91	98	
Soil unit 4:												
Present	71	128	4	100	88	67	0	14	33	0	0	0
Without project	71	128	4	100	96	100	0	4	0	0	2	0
With project	71	128	4	100	99	100	0	1	0	90	91	0
Soil unit 6:												
Present	161	311	8	98	90	57	2	10	43	0	0	0
Without project	161	311	8	98	95	100	2	5	0	0	1	0
With project	161	311	8	99	99	100	1	1	0	90	90	0
Soil unit 8:												
Present	459	324	79	62	35	6	38	65	94	0	0	0
Without project	459	324	79	64	45	6	36	55	94	0	0	0
With project	459	324	79	78	79	6	22	21	94	82	76	0
Soil unit 9:												
Present	251	5		99	100		1	0		49	0	
Without project	251	5		99	100		1	0		49	0	
With project	251	5		100	100		0	0		88	80	
Soil unit 10:												
Present	418	49		71	53		29	47		0	0	
Without project	418	49		73	61		27	39		0	0	
With project	418	49		85	86		15	14		78	74	
Soil unit 11:												
Present	217	158	37	99	95	45	1	5	55	100	100	0
Without project	217	158	37	99	100	100	1	0	0	100	100	0
With project	217	158	37	99	100	100	1	0	0	100	100	0
Soil unit 12:												
Present	329	5		98	100		2	0		0	0	
Without project	329	5		98	100		2	0		0	0	
With project	329	5		100	100		0	0		70	80	
Soil unit 15:												
Present	4			100			0			100		
Without project	4			100			0			100		
With project	4			100			0			100		
Soil unit 16:												
Present	94	1		93	100		7	0		0	0	
Without project	94	1		93	100		7	0		0	0	
With project	94	1		100	100		0	0		80	100	
All:												
Present	2,439	1,689	427	87	75	22	13	25	78	16	12	0
Without project	2,439	1,689	427	88	83	51	12	17	49	16	12	0
With project	2,439	1,689	427	93	95	51	7	5	49	84	90	0

[1] Includes naturally and artificially drained land.

TABLE 113.--Lower Mississippi River and Tributaries Project, Missouri: Estimated effects of project development on cropping systems[1]

Crop	Percentage change in acreage			Percentage change in production			Percentage change in net return		
	A zone	B zone	All land	A zone	B zone	All land	A zone	B zone	All land
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Cotton....................	-2	13	4	16	49	28	61	156	92
Corn......................	4	28	12	53	119	74	9	130	91
Alfalfa...................	30	24	22	36	43	37	40	50	43
Soybeans..................	-3	-18	-9	19	13	15	32	32	30
Wheat.....................	22	36	26	35	60	42	43	70	50
Lespedeza pasture.........	304	111	245	364	231	330	362	287	340
Grain sorghum.............	-41	-56	-58	-15	-43	-45	3	-36	0
Permanent pasture.........	76	287	121	105	442	170	94	401	151
Melons....................	-2		2	10		14	38		45
Idle......................	-66	-100	-70						
Other.....................	7	15	9						
Woodland..................	-46	-69	-43	-46	-69	-41	-41	-68	-40
All land.............	0	0	0	32	53	38	54	73	58

[1] No change in acreage, production, or net return in C zone. "All land" includes C zone.

TABLE 114.--Lower Mississippi River and Tributaries Project, Missouri: Estimated future crop acreages, crop production and net return without and with project development

Crop	Without project			With project			Difference in net return	Percentage increase in net return
	Acres	Production[1]	Net return	Acres	Production[1]	Net return		
	100 acres	*1,000 units*	*1,000 dollars*	*100 acres*	*1,000 units*	*1,000 dollars*	*1,000 dollars*	*Percent*
Cotton..............	694	45	474	720	58	910	436	92
Corn................	839	2,366	1,367	942	4,127	2,608	1,241	91
Alfalfa.............	55	17	154	67	25	221	67	43
Soybeans............	1,152	2,238	2,202	1,048	2,576	2,862	660	30
Wheat...............	370	747	345	464	1,021	518	173	50
Lespedeza pasture....	[2] (67)	874	65	(230)	3,762	286	221	340
Grain sorghum........	14	25	14	8	21	14	0	0
Permanent pasture....	183	2,660	284	405	7,172	714	430	151
Melons..............	12	359	11	12	412	16	5	45
Idle................	50			15				
Other...............	374			408				
Woodland............	812		372	466		223	-149	-40
Total...........	4,555		5,288	4,555		8,372	3,084	58

[1] Cotton - 500-pound bales; corn, soybeans, and grain sorghum - bushels; rice - hundredweights; beef - pounds.
[2] Duplicated acreage.

maintenance of the drainage systems. As shown in table 115, the annual increase in net agricultural income was estimated at $3,084,000; the discounted values of annual increase in net agricultural income and annual associated costs at $2,320,000 and $603,000, respectively.

TABLE 115.--Mississippi River and Tributaries Project Area in Missouri: Project summary

Item	Amount	Item	Amount
Drainage operations:		Associated costs--Continued	
Woodland converted to open cropland	*Acres* 34,600	Annual equivalent:	*Dollars*
Farmland drained	273,200	Conversion	114,000
		Farm drainage	179,000
		Group drainage	136,000
		Annual farm drainage maintenance	243,000
Associated costs:		Total annual costs	672,000
Initial:	*Dollars*	Annual increase in net farm income	3,084,000
Woodland conversion	2,201,000	Discounted value of:	
Farm drainage installations	2,029,000	Annual increase in net farm income	2,320,000
Group drainage installations	1,155,000	Annual associated costs	603,000
Total associated costs	5,385,000	Unadjusted benefits	1,717,000

PROPOSED WATER-CONTROL PROJECTS IN TENNESSEE

West Tennessee Tributaries

The West Tennessee Tributaries to the Mississippi River (fig. 44) include Forked Deer River and its tributaries, the Hatchie and Tuscumbia Rivers, the Loosahatchie River and its tributaries, and the Obion River and its tributaries. The West Tennessee Tributaries provide the principal drainage outlets for all the runoff water in western Tennessee west of the Tennessee River and north of the Wolf River and also for small portions of Kentucky and Mississippi. The rivers are principally hill tributaries. The flood plains consist of comparatively narrow strips of land on each side of the river.

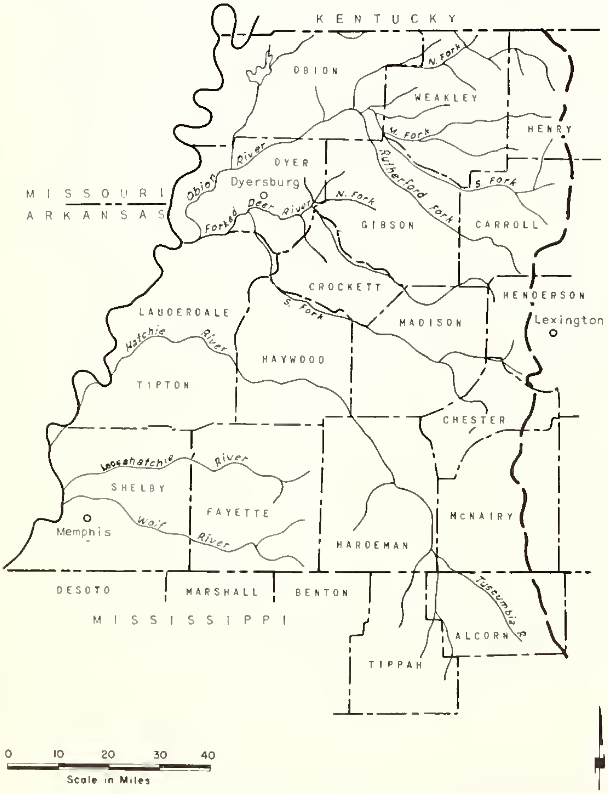


Figure 44.--Location map of West Tennessee Tributaries Project.

The West Tennessee Tributaries Project covers about 683,600 acres, of which 53,700, or about 8 percent, comprise flood-free land; 125,200 acres, or about 18 percent, are subject to flooding; and 504,700 acres, or about 74 percent, is low wet land that would not benefit from project drainage. The soils consist of about 80,600 acres of alluvial soils of the Mississippi River flood plain and about 603,000 acres of alluvial soils of the West Tennessee tributaries flood plains. The project proposes to relieve flooding from backwater and overflow and to improve drainage by channel enlargement, realignment and channel clearing of these tributary streams.

Forked Deer River and its tributaries area

This area is south of the Obion River. It is a tributary of the Obion River, but its confluence with the Obion is near the Mississippi River. The Forked Deer River serves as the principal drainage outlet for runoff from all of Crockett County and parts of Lauderdale, Dyer, Gibson, Carroll, Henderson, McNairy, Chester, Madison, and Haywood Counties, Tenn.

Some channel-improvement work was done on the upper reaches of the Forked Deer River and its tributaries from about 1916 to the early twenties. This work consisted of new channels;, one on the North and Middle Forks downstream to the vicinity of Dyersburg, Tenn., where the two channels converge; on the South Fork down to the vicinity of Fowlkes, Tenn.

Improvement work proposed on the Forked

Deer River and its tributaries consists of clearing, snagging, and some realignment and enlargement of existing channels.

The Forked Deer Project area consists of 7,700 acres of alluvial soils of the Mississippi River flood plain, none of which would benefit from project drainage; and 182,300 acres of alluvial soils derived from loess and loess mixed with coastal-plain materials. A total of 11,700 acres consists of medium-textured moderately well-drained and some poorly drained bottom and low terrace soils, of which 4,500 acres lie above the contour of the flood of record and are flood-free; 4,600 acres are subject to flooding in some degree; and 2,600 acres would be below the 3-year flood frequency line after project construction and would not benefit from project drainage. About 155,100 acres are comprised of medium- and moderately fine-textured, poorly and somewhat poorly drained bottom soils. Of this land, 10,100 acres are flood-free, 36,000 acres are subject to flood and overflow which would be relieved by the proposed project, and 109,000 acres occupy low positions that would not benefit from project drainage. About 1,900 acres of medium-textured, well-drained and moderately well-drained loess terrace soils occur in the zone subject to flooding. About 13,600 acres of medium-textured, poorly drained and somewhat poorly drained loess terrace soils with fragipans occur within the project area. Of this land, 4,500 acres are subject to flooding, and 9,100 acres are too low to benefit from project drainage.

The existing land use pattern consists of 44 percent open land, 55 percent woodland, and 1 percent watered area. About 8 percent of the land area of the basin lies within the A zone, 25 percent within the B zone, and 67 percent within the C zone. About 3 percent of the timbered area is in the A zone, 12 percent in the B zone, and 85 percent in the C zone. About 79 percent of the land in the A zone, 73 percent of the land in the B zone, and 31 percent of the land in the C zone is open land. USDA estimated that if flood protection and drainage were provided within the basin, 98 percent of the land in the A zone, 96 percent of the land in the B zone, and 35 percent of the land in the C zone would be open land. It was expected that with project development 86 percent of all open land in the A zone, 83 percent of all open land in the B zone, and none of the open land in the C zone would be drained. Changes in major land use and in the amount of open land drained by soil units and zones, anticipated to occur are shown in table 116.

USDA estimated that if adequate flood protec-

TABLE 116.--Forked Deer River Basin: Major land use and drainage, present and estimated future without and with project, soil units and zones

Item	All land in zone			Percentage of zone in--						Percentage of open land drained[1]		
				Open land			Woodland					
	A	B	C	A	B	C	A	B	C	A	B	C
	100 acres	*100 acres*	*100 acres*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Soil unit 2:												
Present			77			25			75			0
Without project			77			33			67			0
With project			77			33			67			0
Soil unit 7:												
Present	45	46	26	92	85	91	8	15	9	5	5	0
Without project	45	46	26	94	87	100	6	13	0	10	10	0
With project	45	46	26	99	99	100	1	1	0	82	90	0
Soil unit 8:												
Present	101	360	1,090	73	70	27	27	30	73	5	3	0
Without project	101	360	1,090	76	74	30	24	26	70	10	6	0
With project	101	360	1,090	98	95	30	2	5	70	89	82	0
Soil unit 9:												
Present		19			98			2			4	
Without project		19			98			2			10	
With project		19			100			0			88	
Soil unit 10:												
Present		45	91		77	63		23	37		4	0
Without project		45	91		80	67		20	33		9	0
With project		45	91		96	67		4	33		81	0
All:												
Present	146	470	1,284	79	73	31	21	27	69	5	3	0
Without project	146	470	1,284	82	76	35	18	24	65	10	7	0
With project	146	470	1,284	98	96	35	2	4	65	86	83	0

[1] Includes naturally and artifically drained land.

tion and drainage were provided, total agricultural production could be increased 46 percent and annual net agricultural income 51 percent in the Forked Deer River Basin. These increases are expected to occur as a result of changes in cropping patterns and major land use, as shown in tables 117 and 118.

Assuming adequate flood protection and drainage, USDA estimated that with the project 11,400 acres of woodland would be converted to open land. Of the converted woodland, 11,100 acres are expected to be drained. USDA estimated that 41,300 acres of farmland, including the drained converted woodland, would be drained with the project.

As shown in table 119, USDA estimated the associated cost of land development in the Forked Deer River Basin at $2,860,300, with the annual equivalent at $387,800 including $70,800 for annual maintenance of farm drainage systems. The annual increase in net agricultural income was estimated at $727,300. The

TABLE 117.--Forked Deer River Basin: Estimated effects of project development on cropping systems[1]

Crop	Percentage change in acreage			Percentage change in production			Percentage change in net return		
	A zone	B zone	All land	A zone	B zone	All land	A zone	B zone	All land
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Cotton	45	46	30	110	110	74	271	476	273
Corn	22	81	26	90	181	13	117	233	89
Soybeans	3	9	5	31	53	29	40	83	44
Green vegetables		62	42		108	84		161	123
Lima beans		62	56		94	67		168	150
Permanent pasture	36	13	9	108	80	43	114	89	46
Idle	-67	-61	-25						
Other	20	25	12						
Woodland	-90	-82	-12	-90	-82	-12	-78	-66	-11
All land	0	0	0	77	93	46	88	116	51

[1] No change in acreage, production, or net return in C zone. "All land" includes C zone.

TABLE 118.--Forked Deer River Basin: Estimated future crop acreages, crop production, and net return without and with project development

Crop	Without project			With project			Difference in net return	Percentage increase in net return
	Acres	Production[1]	Net return	Acres	Production[1]	Net return		
	100 acres	*1,000 units*	*1,000 dollars*	*100 acres*	*1,000 units*	*1,000 dollars*	*1,000 dollars*	*Percent*
Cotton	109	6	44	141	11	164	120	273
Corn	206	514	262	260	584	496	234	89
Soybeans	279	516	484	291	665	695	211	44
Green vegetables	12	5.7	43	17	10.5	96	53	123
Lima beans	(10)	.3	6	(16)	.5	15	9	150
Permanent pasture	164	3,174	286	179	4,528	418	132	46
Idle	62			46				
Other	92			104				
Woodland	976		296	862		264	-32	-11
Total	1,900		1,421	1,900		2,148	727	51

[1] Cotton--500-pound bales; corn, soybeans, oats, and grain sorghum--bushels; rice-hundredweights; beef--pounds.

TABLE 119.--Forked Deer River Basin: Project summary

Item	Amount
Drainage operations:	
Woodland converted to open cropland	*Acres* 11,400
Farmland drained	41,300
Associated costs:	
Initial:	*Dollars*
Woodland conversion	1,328,600
Farm drainage installations	677,700
Group drainage installations	854,000
Total associated costs	2,860,300
Annual equivalent:	
Conversion	133,500
Farm drainage	87,800
Group drainage	95,700
Annual farm drainage maintenance	70,800
Total annual costs	387,800
Annual increase in net farm income	727,300
Discounted value of:	
Annual increase in net farm income	509,000
Annual associated costs	311,000
Unadjusted benefits	198,000

discounted value of the annual increase in net agricultural income and of annual equivalent associated costs were estimated at $509,000 and $311,000, respectively.

Hatchie-Tuscumbia Basin

The proposed project in the Hatchie-Tuscumbia Basin consists of channel improvement of the Hatchie River beginning at its confluence with the Mississippi River and extending upstream to the Alcorn-Tippah County line in Mississippi. Channel improvement on the Tuscumbia River is planned from the confluence of the Hatchie and Tuscumbia Rivers upstream to about 1 mile south of the Alcorn-Prentiss County line in Mississippi.

The project area contains 209,700 acres, of which 170,000 acres are in Tennessee and 39,700 acres are in Mississippi. Of the area, 21,300 acres, or about 10 percent, lie above the contour line of the flood of record and are free from flooding and overflow. About 34,200 acres, or 16 percent, are subject to flooding which would be alleviated by the project; and 154,200 acres, or 74 percent, are situated too low to benefit.

The soils are typical of the alluvial soils derived from loess and loess mixed with coastal plain materials.

At present, 77 percent of the land in the A zone, 57 percent of the land in the B zone, and 24 percent of the land in the C zone is woodland. USDA estimated that, assuming adequate flood protection and drainage, 96 percent of the land in the A zone, 86 percent of the land in the B zone, and 25 percent of the land in the C zone would be open land. It was estimated that 81 percent of the open land in the A zone, 77 percent of the open land in the B zone, and none of the open land in the C zone would be drained with the project. The changes in major land use and in the percentage of open land drained, by soil units and by zones, estimated to occur with project development are shown in table 120.

USDA estimated that total agricultural production could be increased 35 percent and annual net agricultural income 42 percent if adequate flood protection and drainage were provided in the Hatchie-Tuscumbia River subproject. These increases are expected to result from estimated changes in major land use and cropping patterns, as shown in tables 121 and 122.

As indicated in table 123, USDA estimated that with the project 13,000 acres of woodland would be converted to open land. Of the woodland expected to be converted, 12,200 acres would be drained. The total associated cost of land development in the area was estimated at $2,843,300, with the annual equivalent including annual maintenance of farm drainage at $310,600.

The total annual increase in net agricultural income was estimated by USDA at $514,600. The discounted value of annual increase in net agricultural income and of annual equivalent associated costs were estimated at $360,000 and $250,000, respectively.

TABLE 120.--Hatchie-Tuscumbia Basin: Major land use and drainage, present and estimated future without and with project, soil units and zones

Item	All land in zone			Percentage of zone in--						Percentage of open land drained[1]		
				Open land			Woodland					
	A	B	C	A	B	C	A	B	C	A	B	C
	100 acres	*100 acres*	*100 acres*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Soil unit 7:												
Present	29	12	56	77	82	87	23	18	13	5	9	0
Without project	29	12	56	79	88	89	21	12	11	16	15	0
With project	29	12	56	98	97	89	2	3	11	91	89	0
Soil unit 8:												
Present	59	312	1,458	52	54	20	48	46	80	4	5	0
Without project	59	312	1,458	55	56	21	45	44	79	13	8	0
With project	59	312	1,458	91	85	21	9	15	79	82	77	0
Soil unit 9:												
Present	1	3	7	100	93	100	0	7	0	100	24	0
Without project	1	3	7	100	93	100	0	7	0	100	35	0
With project	1	3	7	100	98	100	0	2	0	100	83	0
Soil unit 10:												
Present	124	15	15	88	91	94	12	9	6	5	8	0
Without project	124	15	15	89	92	94	11	8	6	10	14	0
With project	124	15	15	97	98	94	3	2	6	77	78	0
Soil unit 12:												
Present			6			32			68			0
Without project			6			32			68			0
With project			6			32			68			0
All:												
Present	213	342	1,542	77	57	24	23	43	76	5	6	0
Without project	213	342	1,542	78	59	25	22	41	75	12	9	0
With project	213	342	1,542	96	86	25	4	14	75	81	77	0

[1] Includes naturally and artificially drained land.

TABLE 121.--Hatchie-Tuscumbia Basin: Estimated effects of project development on cropping systems[1]

Crop	Percentage change in acreage			Percentage change in production			Percentage change in net return		
	A zone	B zone	All land	A zone	B zone	All land	A zone	B zone	All land
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Cotton	13	83	30	58	906	67	318	185	338
Corn	52	75	26	114	197	55	134	154	68
Soybeans	27	97	30	54	237	57	62	180	70
Lespedeza hay		-78	-50		-70	-50		-74	-44
Permanent pasture	19	31	10	83	160	-2	107	106	62
Idle	-32	-22	-8						
Other	22	46	17						
Woodland	-80	-66	-10	-80	-66	-10	-64	-64	-9
All land	0	0	0	58	155	35	86	104	42

[1] No change in acreage, production, or net return in C zone. "All land" includes C zone.

TABLE 122.--Hatchie-Tuscumbia Basin: Estimated future crop acreages, crop production, and net return without and with project development

Crop	Without project			With project			Difference in net return	Percentage increase in net return
	Acres	Production[1]	Net return	Acres	Production[1]	Net return		
	100 acres	*1,000 units*	*1,000 dollars*	*100 acres*	*1,000 units*	*1,000 dollars*	*1,000 dollars*	*Percent*
Cotton.............	107	6	39	139	10	171	132	338
Corn................	180	480	250	226	742	421	171	68
Soybeans............	164	313	302	214	490	512	210	70
Lespedeza hay.......	43	8	16	22	4	9	-7	-44
Permanent pasture...	136	2,488	89	150	2,445	144	55	62
Idle................	44			40				
Other...............	75			88				
Woodland............	1,348		533	1,218		487	-46	-9
Total..........	2,097		1,229	2,097		1,744	515	42

[1] Cotton--500-pound bales; corn, soybeans, oats, and grain sorghum--bushels; rice--hundredweights; beef--pounds.

TABLE 123.--Hatchie-Tuscumbia Basin: Project summary

Item	Amount
Drainage operations:	
Woodland converted to open cropland......................	*Acres* 13,000
Farmland drained................	31,800
Associated costs:	
Initial:	*Dollars*
Woodland conversion...........	1,232,200
Farm drainage installations....	507,400
Group drainage installations...	1,103,700
Total associated costs.......	2,843,300
Annual equivalent:	
Conversion...................	67,600
Farm drainage................	65,700
Group drainage...............	123,600
Annual farm drainage maintenance.	53,700
Total annual costs...........	310,600
Annual increase in net farm income.	514,600
Discounted value of:	
Annual increase in net farm income........................	360,000
Annual associated costs..........	250,000
Unadjusted benefits..........	110,000

Loosahatchie River Basin

The project area of Loosahatchie River contains 38,100 acres. Of the area, 4,600 acres are subject to some degree of flooding and overflow which would be alleviated by the proposed project. About 33,500 acres are in the low area below the zone of project drainage effectiveness and thus would not benefit.

The proposed project consists of channel improvement including some new channel, channel realignment, clearing, and snagging.

The soils that would benefit from the project are alluvial soils derived from loess and loess mixed with coastal-plain materials.

About 3,800 acres of the area to benefit are medium and moderately fine-textured, poorly and somewhat poorly drained bottom lands; about 200 acres are medium-textured, well-drained and moderately well-drained loess terrace; and 600 acres are medium-textured, poorly drained, and somewhat poorly drained loess terrace soils with fragipans.

The Loosahatchie River Basin subproject contains 38,100 acres, of which 12 percent is in the B zone and 88 percent in the C zone. All land in this subproject lies below the contour of the flood of record. At present, 19 percent of the land in the B zone and 53 percent of the land in the C zone is woodland. USDA estimated that if adequate flood protection and drainage were provided, 96 percent of all land in the B zone and 49 percent of all land in the C zone would be open land. Under these assumptions of project development, USDA estimated that 79 percent of all open land in the B zone and none of the open land in the C zone would be drained. The changes in major land use and percentage of open land drained anticipated are shown in table 124.

USDA estimated that with project development total agricultural production could be increased 11 percent and annual net agricultural income 19 percent. These increases would result from estimated changes in major land use and in cropping patterns, as shown in tables 125 and 126.

TABLE 124.--Loosahatchie River Basin: Major land use and drainage, present and estimated future without and with project, soil units and zones

Item	All land in zone			Percentage of zone in--						Percentage of open land drained[1]		
				Open land			Woodland					
	A	B	C	A	B	C	A	B	C	A	B	C
	100 acres	*100 acres*	*100 acres*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*
Soil unit 5:												
Present			2			11			89			0
Without project			2			11			89			0
With project			2			11			89			0
Soil unit 6:												
Present			2			31			69			0
Without project			2			31			69			0
With project			2			31			69			0
Soil unit 7:												
Present			11			95			5			0
Without project			11			95			5			0
With project			11			95			5			0
Soil unit 8:												
Present		38	295		80	41		20	59		0	0
Without project		38	295		85	44		15	56		5	0
With project		38	295		96	44		4	56		80	0
Soil unit 9:												
Present		2	7		79	99		21	1		0	0
Without project		2	7		84	99		16	1		5	0
With project		2	7		96	99		4	1		76	0
Soil unit 10:												
Present		6	18		90	95		10	5		0	0
Without project		6	18		92	95		8	5		5	0
With project		6	18		98	95		2	5		76	0
All:												
Present		46	335		81	47		19	53		0	0
Without project		46	335		86	49		14	51		5	0
With project		46	335		96	49		4	51		79	0

[1] Includes naturally and artificially drained land.

TABLE 125.--Loosahatchie River Basin: Estimated effects of project development on cropping systems[1]

Crop	Percentage change in acreage			Percentage change in production			Percentage change in net return		
	A zone	B zone	All land	A zone	B zone	All land	A zone	B zone	All land
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Cotton		0	0		55	14		551	92
Corn		22	3		86	12		115	17
Soybeans		39	12		92	28		129	38
Permanent pasture		0	0		55	10		60	11
Idle		0	0						
Other		13	3						
Woodland		-75	-3		-75	-3		-75	-3
All land		0	0		60	11		122	19

[1] No change in acreage, production, or net return in C zone. "All land" includes C zone.

TABLE 126.--Loosahatchie River Basin: Estimated future crop acreages, crop production, and net return without and with project development

Crop	Without project			With project			Difference in net return	Percentage increase in net return
	Acres	Production[1]	Net return	Acres	Production[1]	Net return		
	100 acres	*1,000 units*	*1,000 dollars*	*100 acres*	*1,000 units*	*1,000 dollars*	*1,000 dollars*	*Percent*
Cotton..............	57	2.9	18	57	3.3	35	17	94
Corn................	58	140	73	59	157	85	12	16
Soybeans............	22	40	38	25	51	52	14	37
Permanent pasture....	37	738	78	37	813	87	9	12
Idle................	10			10				
Other...............	20			21				
Woodland............	177		53	172		52	-1	-2
Total...........	381		260	381		311	51	19

[1]Cotton--500-pound bales; corn, soybeans, oats, and grain sorghum--bushels; rice--hundredweights; beef - pounds.

As indicated in table 127, with project development 500 acres of woodland are expected to be converted to open land. It was anticipated that 2,900 acres of farmland, including all the converted woodland, would be drained with the project. The total associated cost of land development with the project was estimated at $174,600, with the annual equivalent including annual cost of farm drainage maintenance at $28,300.

TABLE 127.--Loosahatchie River Basin: Project summary

Item	Amount
Drainage operations:	
Woodland converted to open cropland......................	*Acres* 500
Farmland drained................	2,900
Associated costs:	
Initial:	*Dollars*
Woodland conversion...........	84,100
Farm drainage installations....	47,000
Group drainage installations...	43,500
Total associated costs.......	174,600
Annual equivalent:	
Conversion....................	7,300
Farm drainage.................	11,100
Group drainage................	4,900
Annual farm drainage maintenance.	5,000
Total annual costs..........	28,300
Annual increase in net farm income.	51,000
Discounted value of:	
Annual increase in net farm income.......................	35,000
Annual associated costs..........	19,000
Unadjusted benefits..........	16,000

Total annual increase in net agricultural income was estimated to be $51,000. The discounted value of annual increase in net agricultural income and of annual equivalent associated costs were estimated at $35,000 and $19,000, respectively.

Obion River and its tributaries

This river and its tributaries is the most northern of the West Tennessee tributaries. It provides drainage for the runoff west of the Tennessee River watershed from Obion and Weakley Counties and parts of Lauderdale, Henry, Carroll, Gibson, Lake, and Dyer Counties, Tenn., and portions of Fulton and Hickman Counties, Ky. A total of 245,800 acres is included within the Obion River Project area studied.

Some channel-improvement work was done on the upper reaches of the Obion River from 1914 to the early twenties. This work consisted of new channels on the North, Middle, and South Forks, and on Rutherford Creek. The channel improvement extended downstream on the Obion River to a point 3 miles west of the town of Obion, Tenn., but not far enough to reach an adequate outlet. The proposed project would extend the improvement upstream from mile 20 on the Obion River to the junction of the North and South Forks of the river. From this point, the improvement would extend upstream on the North Fork to a point due north of Terrell, Tenn.; on the South Fork to a point 1 mile east of the Illinois Central Railroad; on the Middle Fork to State Highway 54; and on the Rutherford Fork to a point 1 mile east of State Highway 54. The project, which is designed to improve these tributaries as outlets for farm and group drainage, would consist of channel enlargement,

cleanout, and realignment. Some cutoffs are planned on the lower reaches of the Obion River.

Within the Obion River Project area are 78,200 acres of Mississippi River alluvial soils and 167,600 acres of tributary alluvium. Of the Mississippi River alluvial soils, only 2,500 acres lie above the permanently wet sump area. These 2,500 acres are composed of moderately fine-textured, somewhat poorly drained bottom land and low terrace. The soils are somewhat permeable to water and plant roots but the usually high water table causes poor internal drainage. The remaining 75,700 acres of Mississippi River alluvial soils occupy the sump area and would not benefit from project drainage. The 167,600 acres of tributary alluvium in the Obion River area consist of 14,500 acres of medium-textured, moderately well-drained, and somewhat poorly drained bottom land and low terrace soils; 137,900 acres of medium and moderately fine-textured, poorly and somewhat poorly drained bottom-land soils; 1,700 acres of medium-textured, well-drained, and moderately well-drained loess terrace; and 19,300 acres of medium-textured, poorly drained, and somewhat poorly drained loess terrace soils with fragipans. Of the 167,600 acres of tributary alluvial soils in the Obion River area, 15,300 acres are flood-free; 39,400 acres are subject to flooding and backwater overflow, which would be relieved by the project; and 112,900 acres occupy the sump area that would not benefit from project drainage.

Seven percent of the Obion River Basin subproject lies within the A zone, 16 percent in the B zone, and 77 percent in the C zone. At present, 92 percent of the land in the A zone, 72 percent of the land in the B zone, and 32 percent of the land in the C zone is open land. USDA estimated that if adequate flood protection and drainage were provided in the subproject area, 99 percent of the land in the A zone, 97 percent of the land in the B zone, and 39 percent of the land in the C zone would be open land. USDA expected that 89 percent of the open land in the A zone, 83 percent of the open land in the B zone, and none of the open land in the C zone would be drained. The changes in major land use and in the percentage of open land drained estimated to occur with project development are shown in table 128.

Under assumptions of adequate flood protection and drainage, USDA estimated that total agricultural production in the Obion River Basin could be increased 19 percent and annual net agricultural income 23 percent. These increases were expected to result from the estimated changes in major land use and cropping patterns shown in tables 129 and 130.

Woodland to the extent of 8,500 acres was expected by USDA to be converted to open land with the project. Of the converted acreage, 8,300 acres were expected to be drained. USDA estimated that 37,800 acres of farmland, including the drained converted woodland, would be drained with the project.

As indicated in table 131, the total associated cost of land development in the Obion River Basin was estimated by USDA at $1,982,600, the annual equivalent of which was estimated at $280,200 including annual cost of farm drainage maintenance. The total increase in annual net agricultural income was estimated at $547,000. The total discounted value of increase in net agricultural income and of annual equivalent associated costs were estimated at $383,000 and $224,000, respectively.

TABLE 128.--Obion River Basin: Major land use and drainage, present and estimated future without and with project, soil units and zones

Item	All land in zone			Percentage of zone in--						Percentage of open land drained[1]		
				Open land			Woodland					
	A	B	C	A	B	C	A	B	C	A	B	C
	100 acres	*100 acres*	*100 acres*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Soil unit 1:												
Present................			82			11			89			0
Without project.........			82			29			71			0
With project...........			82			29			71			0
Soil unit 2:												
Present................	25		500	82		42	18		58	5		0
Without project.........	25		500	89		53	11		47	9		0
With project...........	25		500	99		53	1		47	91		0
Soil unit 5:												
Present................			74			44			56			0
Without project.........			74			55			45			0
With project...........			74			55			45			0

See footnote at end of table.

TABLE 128.--Obion River Basin: Major land use and drainage, present and estimated future without and with project, soil units and zones--Continued

Item	All land in zone			Percentage of zone in--						Percentage of open land drained[1]		
				Open land			Woodland					
	A	B	C	A	B	C	A	B	C	A	B	C
	100 acres	*100 acres*	*100 acres*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*
Soil unit 6:												
Present			43			40			60			0
Without project			43			52			48			0
With project			43			52			48			0
Soil unit 7:												
Present	49	28	68	96	80	38	4	20	62	22	6	0
Without project	49	28	68	97	86	51	3	14	49	27	11	0
With project	49	28	68	100	99	51	0	1	49	88	82	0
Soil unit 8:												
Present	34	263	1,082	85	64	25	15	36	75	6	4	0
Without project	34	263	1,082	89	70	29	11	30	71	11	8	0
With project	34	263	1,082	99	95	29	1	5	71	84	83	0
Soil unit 9:												
Present		11	6		91	90		9	10		4	0
Without project		11	6		94	95		6	5		14	0
With project		11	6		99	95		1	5		83	0
Soil unit 10:												
Present	70	92	31	95	92	87	5	8	13	6	4	0
Without project	70	92	31	97	94	95	3	6	5	12	10	0
With project	70	92	31	100	99	95	0	1	5	92	82	0
All:												
Present	178	394	1,886	92	72	32	8	28	68	10	4	0
Without project	178	394	1,886	95	77	39	5	23	61	16	9	0
With project	178	394	1,886	99	97	39	1	3	61	89	83	0

[1] Includes naturally and artificially drained land.

TABLE 129.--Obion River Basin: Estimated effects of project development on cropping systems[1]

Crop	Percentage change in acreage			Percentage change in production			Percentage change in net return		
	A zone	B zone	All land	A zone	B zone	All land	A zone	B zone	All land
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Cotton	34	30	15	77	96	33	126	560	76
Corn	2	44	10	41	122	25	53	164	32
Soybeans	1	7	2	22	41	16	30	63	23
Permanent pasture	5	36	8	44	114	30	54	126	33
Idle	-1	-6	-2						
Other	5	25	7						
Woodland	-90	-85	-7	-90	-85	-7	-77	-85	-6
All land	0	0	0	40	72	19	44	98	23

[1] No change in acreage, production, or net return in C zone. "All land" includes C zone.

TABLE 130.--Obion River Basin: Estimated future crop acreages, crop production, and net return without and with project development

Crop	Without project			With project			Difference in net return	Percentage increase in net return
	Acres	Production[1]	Net return	Acres	Production[1]	Net return		
	100 acres	*1,000 units*	*1,000 dollars*	*100 acres*	*1,000 units*	*1,000 dollars*	*1,000 dollars*	*Percent*
Cotton..............	90	6	84	103	8	147	63	75
Corn................	377	1,180	669	413	1,480	881	212	32
Soybeans............	357	734	731	365	849	898	167	23
Permanent pasture....	232	4,611	413	251	5,976	550	137	33
Idle................	34			34				
Other...............	120			129				
Woodland............	1,248		524	1,163		492	-32	-6
Total...........	2,458		2,421	2,458		2,968	547	23

[1] Cotton--500-pound bales; corn, soybeans, oats, and grain sorghum--bushels; rice--hundredweights; beef--pounds.

TABLE 131.--Obion River Basin: Project summary

Item	Amount
Drainage operations:	
Woodland converted to open	*Acres*
cropland......................	8,500
Farmland drained................	37,800
Associated costs:	
Initial:	*Dollars*
Woodland conversion...........	967,600
Farm drainage installations....	603,700
Group drainage installations...	411,300
Total associated costs.......	1,982,600
Annual equivalent:	
Conversion....................	92,300
Farm drainage.................	78,200
Group drainage................	46,100
Annual farm drainage maintenance.	63,600
Total annual costs..........	280,200
Annual increase in net farm income.	547,000
Discounted value of:	
Annual increase in net farm	
income........................	383,000
Annual associated costs..........	224,000
Unadjusted benefits.........	159,000

Lower Mississippi River and Tributaries Project in Tennessee

Within the project area in Tennessee are 683,600 acres, 8 percent of which lies within the A zone, 18 percent within the B zone, and 74 percent within the C zone. Presently, 82 percent of the land in the A zone, 69 percent of the land in the B zone, and 30 percent of the land in the C zone is open land. USDA estimated that if adequate flood protection and drainage were provided, 98 percent of the land in the A zone, 93 percent of the land in the B zone, and 34 percent of the land in the C zone would be open land. Assuming adequate flood protection and drainage, USDA anticipated that 85 percent of all open land in the A zone, 81 percent of all open land in the B zone, and none of the open land in the C zone would be drained. The anticipated changes in major land use and percentage of open land drained, by soil units, within each zone, are shown in table 132.

If adequate flood protection and drainage were afforded the project area in Tennessee, total agricultural production could be expected to increase 30 percent and annual net agricultural income 35 percent, according to USDA estimates. These increases are expected to

TABLE 132.--Lower Mississippi River and Tributaries Project, Tennessee: Major land use and drainage, present and estimated future without and with project, soil units and zones

Item	All land in zone			Percentage of zone in--						Percentage of open land drained[1]		
				Open land			Woodland					
	A	B	C	A	B	C	A	B	C	A	B	C
	100 acres	*100 acres*	*100 acres*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Soil unit 1:												
Present.................			82			11			89			0
Without project.........			82			29			71			0
With project............			82			29			71			0
Soil unit 2:												
Present.................	25		577	80		40	20		60	4		0
Without project.........	25		577	88		51	12		49	9		0
With project............	25		577	100		51	0		49	88		0
Soil unit 5:												
Present.................			76			43			57			0
Without project.........			76			54			46			0
With project............			76			54			46			0
Soil unit 6:												
Present.................			45			40			60			0
Without project.........			45			51			49			0
With project............			45			51			49			0
Soil unit 7:												
Present.................	123	86	161	90	83	67	10	17	33	13	6	0
Without project.........	123	86	161	92	87	75	8	13	25	18	11	0
With project............	123	86	161	99	99	75	1	1	25	86	87	0
Soil unit 8:												
Present.................	194	973	3,925	69	64	25	31	36	75	5	4	0
Without project.........	194	973	3,925	72	67	28	28	33	72	11	7	0
With project............	194	973	3,925	96	92	28	4	8	72	86	81	0
Soil unit 9:												
Present.................	1	35	20	100	94	90	0	6	10	100	6	0
Without project.........	1	35	20	100	94	90	0	6	10	100	12	0
With project............	1	35	20	100	97	90	0	3	10	100	85	0
Soil unit 10:												
Present.................	194	158	155	91	88	75	9	12	25	5	4	0
Without project.........	194	158	155	92	90	79	8	10	21	11	10	0
With project............	194	158	155	98	98	79	2	2	21	83	81	0
Soil unit 12:												
Present.................			6			40			60			0
Without project.........			6			40			60			0
With project............			6			40			60			0
All:												
Present.................	537	1,252	5,047	82	69	30	18	31	70	7	4	0
Without project.........	537	1,252	5,047	85	72	34	15	28	66	13	8	0
With project............	537	1,252	5,047	98	93	34	2	7	66	85	81	0

[1] Includes naturally and artificially drained land.

result from the estimated changes in major land use and cropping distributions shown in tables 133 and 134.

As shown in table 135, 33,400 acres of woodland were estimated to be converted to open land with project development in Tennessee. Of the total woodland converted, 32,100 acres were anticipated to be drained. Total farmland to be drained with the project was estimated by USDA at 113,800 acres, including the converted wood-

land drained. Total cost of land development in the project areas in Tennessee was estimated at $7,862,000, with the annual equivalent including annual cost of farm drainage maintenance which was estimated at $1,007,000.

The total increase in annual net agricultural income was estimated by USDA, under assumptions of adequate flood protection and drainage, at $1,840,000. The discounted value of annual increase in net agricultural income and of annual equivalent associated costs were estimated at $1,287,000 and $804,000, respectively.

TABLE 133.--Lower Mississippi River and Tributaries Project, Tennessee: Estimated effects of project development on cropping systems[1]

Crop	Percentage change in acreage			Percentage change in production			Percentage change in net return		
	A zone	B zone	All land	A zone	B zone	All land	A zone	B zone	All land
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Cotton....................	26	48	21	78	122	57	234	607	179
Corn......................	18	62	17	69	147	28	87	191	50
Soybeans..................	11	20	9	35	64	28	43	94	39
Green vegetables..........		62	42		108	84		161	123
Lima beans................		62	56		94	67		168	150
Lespedeza hay.............		-78	-49		-75	-50		-70	-44
Permanent pasture.........	19	24	8	75	59	25	86	109	38
Idle......................	-34	-39	-13						
Other.....................	15	29	11						
Woodland..................	-84	-76	-9	-84	-76	-9	-64	-70	-8
All land..............	0	0	0	57	91	30	69	117	35

[1] No change in acreage, production, or net return in C zone. "All land" includes C zone.

TABLE 134.--Lower Mississippi River and Tributaries Project, Tennessee: Estimated future crop acreages, crop production and net return without and with project development

Crop	Without project			With project			Difference in net return	Percentage increase in net return
	Acres	Production[1]	Net return	Acres	Production[1]	Net return		
	100 acres	*1,000 units*	*1,000 dollars*	*100 acres*	*1,000 units*	*1,000 dollars*	*1,000 dollars*	*Percent*
Cotton...............	363	21	185	440	32	517	332	179
Corn.................	821	2,314	1,254	958	2,963	1,883	629	50
Soybeans.............	822	1,603	1,555	895	2,055	2,157	602	39
Green vegetables.....	12	5.7	43	17	10.5	96	53	123
Lima beans...........	(10)	.3	6	(16)	.5	15	9	150
Lespedeza hay........	43	8	16	22	4	9	-7	-44
Permanent pasture....	569	11,010	866	617	13,762	1,199	333	38
Idle.................	150			130				
Other................	307			342				
Woodland.............	3,749		1,406	3,415		1,295	-111	-8
Total...........	6,836		5,331	6,836		7,171	1,840	35

[1] Cotton--500-pound bales; corn, soybeans, oats, and grain sorghum--bushels; rice-hundredweights; beef--pounds.

TABLE 135.--Mississippi River and Tributaries Project Area in Tennessee: Project summary

Item	Amount
Drainage operations:	
Woodland converted to open	*Acres*
cropland	33,400
Farmland drained	113,800
Associated costs:	
Initial:	*Dollars*
Woodland conversion	3,613,000
Farm drainage installations	1,836,000
Group drainage installations	2,413,000
Total associated costs	7,862,000

Item	Amount
Associated costs--Continued	
Annual equivalent:	*Dollars*
Conversion	301,000
Farm drainage	243,000
Group drainage	270,000
Annual farm drainage maintenance	193,000
Total annual costs	1,007,000
Annual increase in net farm income	1,840,000
Discounted value of:	
Annual increase in net farm income	1,287,000
Annual associated costs	804,000
Unadjusted benefits	483,000

HILL-LAND PROBLEM AREAS IN TENNESSEE

A study was made by USDA to estimate sediment production in the principal sediment source areas draining into Reelfoot Lake and that portion of Running Reelfoot Bayou down to and including Paw Paw Creek (fig. 45).

Sedimentation of Reelfoot Lake has been of public concern for many years. Losses from sedimentation of lake capacity and lake area have been progressing since the lake was formed by a subsidence in 1812. Sediment deposition in Running Reelfoot Bayou, outlet to Reelfoot Lake, has resulted in decreased channel capacity, with resulting obstruction to discharge from the lake and impairment to drainage of adjoining lands. This condition has also contributed to the cost of outlet-channel maintenance.

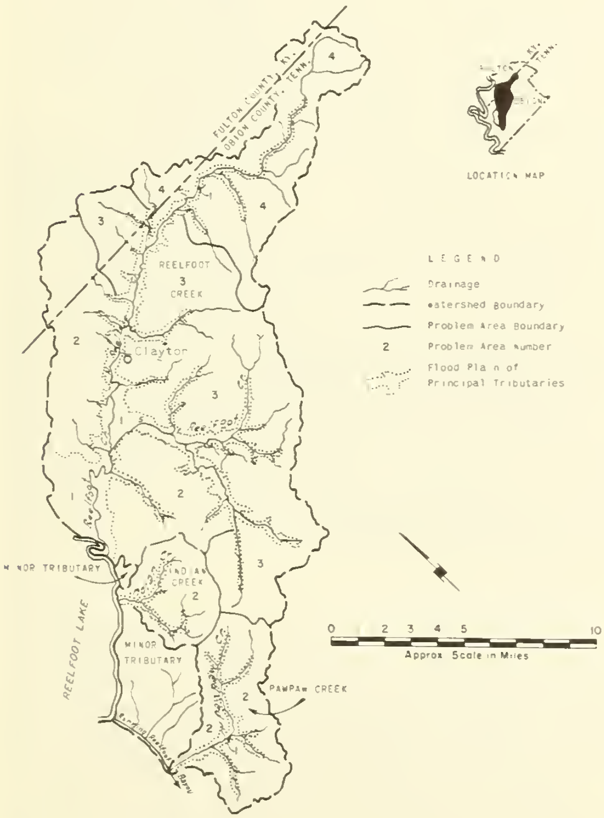


Figure 45.--Eastern Watershed of Reelfoot Lake and Running Reelfoot Bayou to Pawpaw Creek.

The estimated sediment-yield rates as shown in table 136 are for (1) the present condition of ground cover and land management; (2) the future condition of ground cover and land management after 10 years of the going program;[26] (3) the future condition of land cover resulting from an accelerated program for stabilizing critical areas;[27] and (4) the future condition of land cover resulting from an accelerated program for stabilizing both critical areas and steep lands (land-capability classes VI and VII, table 137) that are cultivated. The estimated costs of these programs are shown in table 138.

The watersheds of Reelfoot, Indian, and Paw Paw Creeks, and minor tributaries were divided into problem areas[28] for determining the average sediment-production rate of each. The upland-problem areas of the Reelfoot Creek watershed were further subdivided into land-capability classes as given in table 137 so that detailed analyses of sample areas considered representative of all watersheds covered by the study could be made.

26 Programs affecting agriculture which are presently active in the area. Does not include the small watershed program under Public Law 566.

27 Going program plus protection of gullied land or land adjacent thereto presently not suited for cropland or pasture, by permanent vegetation and possibly other measures necessary to prevent substantial contributions of runoff and sediment.

28 Areas of land having similar patterns of soil, including slopes and erosion, climate, water resources, land use, and types of farming.

TABLE 136.--Estimates of sediment production under various conditions of ground cover and land management, Reelfoot Lake and Running Reelfoot Bayou drainage areas

Item	Annual sediment yield		
	Per square mile[1]		Total
Present conditions:		*Acre-*	*Acre-*
Tributary to Reelfoot Lake:	*Tons*	*feet*	*feet*
Reelfoot Creek............	1,660	1.28	137.0
Indian Creek..............	2,310	1.78	15.5
Minor tributaries.........	2,645	2.05	8.8
Total..................			161.3
Tributary to Running Reelfoot Bayou:			
Paw Paw creek.............	2,180	1.68	25.1
Minor tributaries.........	2,600	2.00	5.6
Total..................			30.7
Future:			
After 10 years of going program:			
Reelfoot Creek...........	1,420	1.09	131.0
Indian Creek.............	2,110	1.62	14.1
Minor tributaries........	2,570	1.98	8.5
Total..................			153.6
Tributary to Running Reelfoot Bayou:			
Paw Paw Creek............	2,030	1.56	23.3
Minor tributaries........	2,420	1.86	5.2
Total..................			28.5
After 10 years of going program and stabilization of critical areas:			
Tributary to Reelfoot Lake:			
Reelfoot Creek...........	1,120	0.86	103.0
Indian Creek.............	1,690	1.30	11.2
Minor tributaries........	1,820	1.40	6.0
Total..................			120.2
Tributary to Running Reelfoot Bayou:			
Paw Paw Creek............	1,480	1.14	17.1
Minor tributaries........	1,770	1.36	3.8
Total..................			20.9
After 10 years of going program and stabilization of critical areas and steep lands:			
Tributary to Reelfoot Lake:			
Reelfoot Creek...........	750	0.58	69.0
Indian Creek.............	1,380	1.06	9.1
Total..................			83.0
Tributary to Running Reelfoot Bayou:			
Paw Paw Creek............	1,220	0.94	14.1
Minor tributaries........	1,440	1.11	3.1
Total..................			17.2

[1] Based on specific weight of sediment of 1,300 tons per acre foot.

Problem Area 1

Problem Area 1 embraces the principal flood plains of the Reelfoot, Indian, and Paw Paw Creek watersheds. It is not considered a sediment-producing area. The sediment deposits on the flood plains are generally considered beneficial to agricultural production, as no infertile overwash (such as sand or gravel) is evident.

The topography of the area is relatively level. The streambanks, in general, are protected with natural vegetation. Scour and flood-plain sheet erosion are not pronounced. The predominantly silt loam soils are comprised of alluvium from adjacent loess hills and vary from poorly to well drained. The soils are farmed primarily for production of cotton, corn, and soybeans, with a less extensive acreage of other crops such as hay and pasture.

Problem Area 2

Problem Area 2 embraces all the uplands of Indian and Paw Paw Creeks, the western portion of Reelfoot Creek, and the intervening minor watersheds that drain directly into the lake and Running Reelfoot Bayou. It includes the steep-bluff area adjacent to the Mississippi River Delta. The ridgetops are generally narrow with sloping relief. Moderately steep to steep hillsides and narrow gently sloping bottoms or valleys intervene between ridgetops. The slopes range from about 2 percent near the ridgetops to about 50 percent on some hillsides.

The soils, derived from thick beds of loess, are deep, friable, and well drained. Memphis silt loam is the predominate soil type. The strong slopes and silty soil cause the area to be very erodible when not properly managed. Runoff is difficult to control and, under clean cultivation, the soil is highly susceptible to erosion. Sheet erosion has been severe (more than 75 percent of the topsoil and some subsoil gone) on most of the cleared hillsides. Erosion on the ridgetops and particularly on the bottom lands has been less severe.

Vegetative cover is poor on cultivated land in the area, fair on idle and pasture land, and good on forest land. Forest is the predominant cover in the area. Cotton, corn, and soybeans are the principal crops, but some hay and pasture are produced.

Problem Area 3

Problem Area 3 is confined to the Reelfoot Creek watershed. It is east of and immediately upstream from Problem Area 2. Most of the ridgetops are relatively wide with sloping relief. Strongly sloping to steep hillsides decline from the ridgetops to the narrow, gently sloping bottoms or valleys. The slopes range from 2 to 50 percent. Usually they are not as steep as those of Problem Area 2, but a larger acreage of steepland has been cleared and cultivated.

The soils were developed from loess and are

TABLE 137.--Size and cost of installation and annual maintenance cost for vegetative stabilization of critical areas and class VI and VII open land needing permanent vegetation, Reelfoot Lake and Running Reelfoot Bayou

Item	Going program[1]			Accelerated program[1 2]		
	Installation		Annual maintenance	Installation		Annual maintenance
	Size	Cost		Size	Cost	
Eastern part to Reelfoot Lake:						
Reelfoot Creek:	*Acres*	*Dollars*	*Dollars*	*Acres*	*Dollars*	*Dollars*
Open land, classes VI and VII........	803	40,632	12,045	6,931	350,709	103,965
Critical areas......................	355	27,635	4,699	3,177	241,936	41,399
Total............................	1,158	68,267	16,744	10,108	592,645	145,364
Indian Creek:						
Open land, classes VI and VII........	15	759	225	151	7,541	2,265
Critical areas......................	35	2,725	435	350	28,957	4,377
Total............................	50	3,484	660	501	36,598	6,642
Small tributaries:						
Open land, classes VI and VII........	15	248	225	152	7,691	2,280
Critical areas......................	16	1,280	207	161	12,720	2,099
Total............................	31	1,528	432	313	20,411	4,379
Total to Reelfoot Lake.........	1,239	73,279	17,836	10,922	649,654	156,385
Eastern part to Running Reelfoot Bayou						
Paw Paw Creek:						
Open land, classes VI and VII........	22	1,113	330	222	11,233	3,330
Critical areas......................	72	5,605	900	723	59,846	9,041
Total............................	94	6,718	1,230	945	71,079	12,371
Small tributaries:						
Open land, classes VI and VII........	10	506	150	99	4,554	1,485
Critical areas......................	11	879	143	105	8,118	1,368
Total............................	21	1,385	293	204	12,672	2,853
Total to Running Reelfoot Bayou......................	115	8,103	1,523	1,149	83,751	15,224
All open land, classes VI and VII........	865	43,258	12,975	7,555	381,828	113,325
All critical areas......................	489	38,124	6,384	4,516	351,577	58,284
Total drainage area..................	1,354	81,382	19,369	12,071	733,405	171,609

[1] Includes 10 percent for technical assistance and contingencies.
[2] Accelerated program for stabilization of critical areas and steepland.

predominantly deep, friable, and well drained. Some areas of moderately deep, moderately well-drained soils with fragipans occur in the area. Memphis silt loam is the predominant soil type.

The strong slopes and silty nature of the soils cause them to be very erodible when not properly managed. Most of the cleared hillsides have been severely eroded. The ridgetops and particularly the bottoms are less severely eroded.

Problem Area 4

Problem Area 4 occurs only in the Reelfoot Creek watershed. It is east of Problem Area 3 and is the area in which North Reelfoot Creek has its origin. This area consists of long, gentle slopes with a few short, steeper slopes.

The soils were developed from loess and vary greatly in depth and drainage, but moderately deep soils with fragipans predominate. Grenada silt loam is the principal soil type.

Erosion in this area is less severe than in Problem Areas 2 and 3. Severe sheet erosion is confined to the relatively few steeper slopes. Gully erosion is not common.

Forests occur primarily in the wet depressional areas and on some of the steeper slopes. Vegetative conditions are poor on cultivated land, fair on idle and pasture, and good on forest land. Corn, small grain, soybeans, and pasture are the principal crops grown in this diversified farming area.

Present land use by land-capability classes and problem areas are summarized in table 138.

The critical areas within the upland drainage area of Reelfoot Lake and Running Reelfoot Bayou were separated into three groups, varying with severity of erosion and percentage of active gullies.

Group I consists of critical areas, 5 percent of which is composed of active sediment-producing gullies, with the remaining 95 per-

TABLE 138.--Land use by capability classes and problem areas, Reelfoot Creek watershed, 1956

Land capability classes	Problem area--															Total watershed
	2					3					4					
	Cultivated land	Forest land	Idle land	Pasture	Total	Cultivated land	Forest land	Idle land	Pasture	Total	Cultivated land	Forest land	Idle land	Pasture	Total	
Recommended for Cultivation:	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*
I	--	--	--	--	--	36	--	--	--	36	15	--	--	--	15	51
IIe	489	549	489	372	1,899	3,986	364	455	1,038	5,843	1,673	15	46	380	2,114	9,856
IIw	235	959	79	293	1,566	1,602	546	346	1,256	3,750	1,034	31	45	46	1,156	6,472
IIs	--	--	--	--	--	18	--	--	--	18	426	--	--	15	441	459
IIIe	568	117	78	59	822	401	91	491	655	1,638	913	106	46	15	1,080	3,540
IIIw	--	--	--	--	--	18	--	--	--	18	1,505	183	--	259	1,947	1,965
IVe	39	59	--	--	98	601	72	18	182	873	456	--	--	61	517	1,488
IVw	--	--	--	--	--	--	--	--	--	--	3,179	319	--	456	3,954	3,954
Total	1,331	1,684	646	724	4,385	6,662	1,073	1,310	3,131	12,176	9,201	654	137	1,232	11,224	27,785
Permanent vegetation only:																
VIe	20	--	19	--	39	2,912	364	801	1,511	5,588	517	--	--	30	547	6,174
VIIe noncritical	274	9,515	448	333	10,570	2,858	2,985	500	2,458	8,801	350	289	111	411	1,161	20,532
VIIe critical	--	--	1,451	--	1,451	--	--	1,685	--	1,685	--	--	41	--	41	3,177
Total	294	9,515	1,918	333	12,060	5,770	3,349	2,986	3,969	16,074	867	289	152	441	1,749	29,883
Grand total	1,625	11,199	2,564	1,057	16,445	12,432	4,422	4,296	7,100	28,250	10,068	943	289	1,673	12,973	57,668
Miscellaneous					265					884					560	1,709
Total problem area	1,625	11,199	2,564	1,057	16,710	12,432	4,422	4,296	7,100	29,134	10,068	943	289	1,673	13,533	59,377
Problem area 1 (flood-plain)																9,139
Total watershed																68,516
Percentage of problem area recommended for-- Cultivation:	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Classes I-IV	8.0	10.0	3.9	4.3	26.2	22.8	3.7	4.5	10.8	41.8	68.0	4.8	1.0	9.1	82.9	40.6
Permanent vegetation only:																
Classes VI-VII	1.8	56.9	11.5	2.0	72.2	19.8	11.5	10.3	13.6	55.2	6.4	2.1	1.1	3.3	12.9	43.6
Miscellaneous					1.6					3.0					4.2	2.5
Total					100.0					100.0					100.0	86.7
Problem area 1 (flood-plain)																13.3
Total watershed																

cent severely eroded. This type of area would require some gully shaping, gully bank-sloping, and sodding to bermudagrass. There are about 1,749 acres, including 88 acres of gullies, of this type of area in the watershed.

Group II consists of critical areas, 25 percent of which is composed of active sediment-producing gullies, with the remaining 75 percent severely eroded. Treatment of the areas in this group would require about twice as much gully shaping and sloping as group I, in addition to sodding with bermudagrass. There are about 1,015 acres, of which 253 are sediment-producing active gullies, in group II.

Group III consists of critical areas, 60 percent of which is composed of active sediment-producing gullies with the remaining 40 percent severely eroded. The gullies in this group are large, deep, and caving. Many such gullies in the Paw Paw Creek Area have resulted from draintile or open ditches for draining basins in the ridgetops. The gullies in this group are too deep for the bank to be pushed in and sloped economically; however, short diversion ditches are adapted and needed so that water can be diverted from the gully heads. The successful diversion of runoff from the gullies would stop the advance of the gully heads up the slope. Fencing of gullies would be necessary to protect the kudzu while becoming established and to reduce the possibility of livestock falling into them after the kudzu has become established. There are about 1,752 acres in the area, of which 1,051 acres are sediment-producing gullies.

Land Treatment Needs and Costs

Cost estimates were based on critical-area treatments expected to be accomplished within the next 10 years of the going program. This estimate of anticipated accomplishment was based on the judgment of local agricultural workers most familiar with the area. Cost estimates for the accelerated program were based on the assumption that 100 percent of the land stabilization needed would be put into effect. However, it would be necessary to adjust any accelerated land-stabilization program to the degree of participation that could be obtained from local landowners.

Estimates of annual maintenance costs for

grasses and legumes were based on those management practices necessary to maintain adequate ground cover. Maintenance cost for kudzu on the larger gullies included maintenance of fences.

Needing permanent vegetation are 7,234 acres of open land on land-capability classes VI and VII presently cultivated in the watersheds draining into Reelfoot Lake. It was estimated that installation of land-treatment measures for these acres would cost $365,941, and that the annual maintenance cost would be $108,510. In addition, 3,688 acres of critical areas need to be stabilized at an estimated cost of $283,613, with an annual maintenance cost of $47,875. A total of 10,922 acres of combined critical areas and critical slopes needs to be treated at an estimated installation cost of $649,654, with an annual maintenance cost estimated at $156,385.

Of open land needing permanent vegetation in the subwatersheds draining into the Running Reelfoot Bayou, 321 acres need to be treated at an estimated installation cost of $15,787, with an annual maintenance cost estimated at $4,815. There are also 828 acres of land with critical areas to be treated at an estimated installation cost of $67,964; and an estimated annual maintenance cost of $10,409. The stabilization of the combined area of open land needing permanent vegetation with critical areas was estimated to cost $83,751, with an estimated annual maintenance cost of $15,224.

There are 7,555 acres of open land needing permanent vegetation in both major watersheds to be stabilized. The estimated installation cost is $381,828 and the estimated annual maintenance cost is $113,325. In addition, there are 4,516 acres of land with critical areas to be stabilized at an estimated installation cost of $351,577 and an annual maintenance cost of $58,284.

Summaries of acreage, cost of installation, and annual maintenance cost are given in table 137 for open land needing permanent vegetation and critical areas for the going program and for the accelerated program. Subtotals are shown separately for the portion of drainage going into Reelfoot Lake and for that going into Running Reelfoot Bayou. Grand total summary figures are shown for acreages, cost of installation, and annual maintenance cost.

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